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CONCEPT OF TECHNOLOGICAL DEVELOPMENT OF SMART FACILITIES

Formation of an Innovative Concept for the Technological Development of a Smart Facility or an Investment Complex

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This work examines the specific features of the design and logistics involved in the formation, technological development, production, and construction of smart facilities or investment complexes, as well as the innovative software components of their infrastructure that ensure maximum technological, economic, and commercial efficiency and, ultimately, the environmental sustainability of formation, construction, and operational processes.

Particular attention is given to the importance and specific characteristics of applying the principles of comprehensive electronic digital forecasting, computer modeling, design, construction, and operation of investment facilities and the infrastructure complex of smart investment and real estate assets. These principles are considered within the framework of creating an integrated system for the organization of development, design, production, and implementation processes. The study also includes examples involving advanced composite materials, laser technologies, and technological systems for food production, medical technology applications, and wastewater regeneration and recirculation systems that fully comply with the requirements and provisions of applicable general and industry-specific standards. Ensuring environmental safety in production technologies in accordance with current standards constitutes a mandatory requirement for the establishment and continued operation of such manufacturing processes.

Prior to the widespread implementation of environmental standards imposing stricter limitations on the concentration of pollutants contained in industrial waste streams, it was generally sufficient to treat waste before disposal at designated waste management facilities. Today, due to the significant tightening of environmental regulations, such treatment processes have become increasingly costly, which ultimately leads to a substantial reduction in the economic efficiency of virtually any industrial production process.

Keywords: *Technological development; Concept of technological development; Concept of technological development of a smart facility; Concept of technological development of an investment complex; Specific features of the design and logistics of the formation, technological development, production, and construction of smart facilities; Importance and specific features of applying the principles of comprehensive electronic digital forecasting; Importance and specific features of applying the principles of comprehensive electronic digital computer modeling; Importance and specific features of applying the principles of comprehensive electronic digital design, construction, and operation of investment facilities and the infrastructure complex of a smart facility; Examples of technological systems for food production, implementation of medical technologies, regeneration and recirculation of wastewater, fully compliant with the requirements and provisions of applicable general and industry-specific standards*

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Introduction

Formation of an Innovative Concept for the Technological Development of a Smart Facility or an Investment Complex

The specific features of the design and logistics of the formation, technological development, production, and construction of smart facilities or investment complexes and their innovative software infrastructure components, ensuring their maximum technological, economic, and commercial efficiency and, ultimately, the environmental sustainability of the processes of formation, construction, and operation.

The importance and specific features of applying the principles of comprehensive electronic digital forecasting, computer modeling, design, construction, and operation of investment facilities and the infrastructure complex of a smart investment and real estate facility in the formation of an integrated system for organizing development, design, production, and implementation processes, including examples of composite materials, laser technologies, and technological systems for food production, implementation of medical technologies, and the regeneration and recirculation of wastewater, fully compliant with the requirements and provisions of applicable general and industry-specific standards.

Inventions in the Field of Computer Security Based on Electromagnetic Resonance and Resonance Spectroscopy Effects

Very often, corporate users of computer networks find themselves powerless against hacker attacks.

Numerous examples may be cited; however, it is sufficient to consider some of the most serious and dangerous cases for users.

The internal computer network of the lower house of the Japanese Parliament was subjected to regular hacker attacks beginning in July 2011. This was repeatedly reported by Reuters, citing the *Asahi Shimbun* newspaper.

According to an anonymous source interviewed by the Japanese newspaper, the attackers obtained passwords to parliamentarians' email accounts through the use of a computer virus. Presumably, the hackers' objective was to obtain information related to Japan's defense policy and international relations.

It was noted that the first compromised computer received the virus from a server registered in China; however, it was not possible to determine who had uploaded the virus to that server.

This was the first hacker attack directed against the computers of the lower house of the Japanese Parliament. There was no information indicating that the hackers had altered or transferred any data contained within the Parliament's internal network.

Reports concerning the cyberattack on the internal network of the Japanese Parliament appeared one month after it became known that the first recorded hacker attack against Japan's defense industry had taken place. On that occasion, the computer network of Mitsubishi Heavy Industries Ltd. (MHI), which manufactures ships, missiles, and components for nuclear power plants, among other products, was compromised.

The Ministry of Justice of Israel also reported, for example, that a contract employee working for the Ministry of Labor and Social Welfare had stolen the personal data of more than nine million Israeli citizens during his period of employment there. The stolen information included identification card numbers, names, addresses, dates of birth, family information, details concerning relatives, and other personal data, which were copied for the purpose of sale.

This information was made public after the police lifted a publication ban on the disclosure of these facts, as reported by Israeli media outlets.

The personal data of Israeli citizens were transferred to an individual who created a computer program known as "Agron-2006," enabling the unlawful use of this database for various purposes.

A report published by *The Jerusalem Post* emphasized that "Agron-2006" made it possible to trace family relationships among millions of Israelis, including infants and individuals who had long since passed away.

A copy of this program, which lacked any security protection, was obtained by a computer technician from Jerusalem, who subsequently made it freely available on the Internet.

The data were organized in the form of a website and accompanied by instructions for downloading.

As part of the investigation into this case, law enforcement authorities detained the technician in June, along with five additional suspects. They were subsequently released on condition that they comply with a number of restrictions.

The Ynet news website notes that information regarding this crime was used in a report prepared by the Department for Complaints Against Government Authorities and Ministries and subsequently presented in the reports of the State Comptroller.

This precedent was discussed in the Knesset, where members of parliament approved a program for the transition to biometric passports.

Threats to user data are diverse and include viruses that, once they infect a computer, continue spreading further; phishing websites designed to deceive users into revealing important information; and, of course, malicious software applications.

Modern web browsers possess built-in protection mechanisms against a number of threats. In particular, they warn users about websites that may pose a risk to their computers. According to NSS Labs, the highest level of protection in such cases in 2010 was provided by the SmartScreen technology integrated into Internet Explorer 8.

Subsequently, leadership passed to Internet Explorer 9, in which SmartScreen was further improved. As of May 2011, the eighth and ninth versions of Microsoft's browser were blocking between two and five million attacks on users' computers every day, which was five times or more than the performance demonstrated by other browsers.

Initially, the principal component of SmartScreen was the verification of webpage addresses for suspicious characteristics. SmartScreen calculates the reputation of webpage addresses. This indicator is influenced by numerous parameters, including the address itself, website traffic frequency, the domain name, IP addresses, and DNS servers that are aware of the existence of the resource. Owing to this comprehensive verification process, malicious actors that have been placed on a blacklist are forced to incur significant expenses in relocating their infrastructure elsewhere.

Internet Explorer learned to identify phishing, that is, fraudulent websites, beginning with its seventh version. Since that time, Microsoft browsers have detected more than 160 million phishing pages. In total, since the release of Internet Explorer 8, approximately 1.5 billion malware-related attacks have been prevented. Overall, Internet Explorer 8 blocks approximately 90 percent of such threats.

The remaining 10 percent of threats were addressed in Internet Explorer 9 when SmartScreen was enhanced with an additional layer of protection – the calculation of application reputation. Such a mechanism does not exist in other browsers.

According to Microsoft, one out of every fourteen downloaded programs is malicious. Users simply do not know how to distinguish a legitimate application from a harmful one. Internet Explorer 9 can provide guidance by evaluating the reputation of a particular program.

Application reputation is determined by several components. The browser monitors digital signatures attached to applications by developers and places greater trust in signed software. Reputation is also influenced by the age of a website – newly created resources are trusted less than websites from which software has been downloaded for a long period of time. Reputation-calculation technologies often make it possible to warn users about the potential malicious nature of a program before antivirus software becomes aware of the threat.

Because most software publishers already possess an established reputation, warnings are unnecessary in approximately 90 percent of cases. The browser issues warnings regarding unknown programs; with a probability ranging from 25 to 70 percent, users who ignore such warnings will download malicious software. Fortunately, 95 percent of users follow the recommendation and do not execute suspicious programs.

The browser raises an alert only in cases of particularly high risk. According to Microsoft's calculations, the average Internet Explorer user encounters such a warning only twice per year.

The results of implementing this system speak for themselves. Recently, Microsoft published a forecast according to which the application reputation mechanism would prevent more than 20 million infections each month. This figure does not include websites blocked by the standard SmartScreen mechanism.

The effectiveness of the system depends upon the volume of accumulated data. Consequently, the longer SmartScreen operates, the closer its protection rate approaches one hundred percent. Accordingly, the number of "saved" computers will continue to increase from month to month.

The author of this book considers it most appropriate, for solving the entire range of problems associated with computer security, to apply an integrative method for the identification of optical information storage media invented by him in cooperation with other innovative specialists, utilizing means and properties inherent in electromagnetic resonance.

Brief Description of the Proposed Innovative Products

A product based on an application technology – a **MICRO-SENSOR DESIGNED FOR INTEGRATION INTO THE SPINDLE ASSEMBLY OF OPTICAL MEMORY READING AND WRITING DEVICES**.

The product is a micro-resonance sensor featuring multiple topology configurations for the arrangement of highly sensitive nano-detectors and a wide variation in the number of such nano-detectors. The sensor is installed within the receiving unit of the spindle assembly of an optical memory drive. The sensor is connected to a software system that identifies signals received from the detectors and issues a command to the drive either to commence operation or to block operation in the absence of proper identification of the optical disk installed in the drive. The coordinates of the nano-detectors must correspond to the coordinates of the encoding nano-implants.

Distinctive Features of the Product:

- High measurement accuracy;
- Simplicity of design;
- Reliability and long service life;
- Complete absence of physical contact with the measured surface;
- Capability of integration into any existing technological architecture of optical memory modules, as well as into modules currently under development, including those intended for terabyte-class optical disks;

- The product consists entirely of standard components, which ensures high reliability, low manufacturing costs, and the possibility of production without specialized technological equipment; detector manufacturing can be carried out using existing semiconductor production equipment;
- Low energy consumption; only a few milliwatts of power are required for sensor operation;
- Capability of monitoring any topology configuration of nano-implant placement;
- Capability of monitoring ultra-pure materials and identifying materials that differ at the isotopic level;
- Capability of integration into automatic control systems not necessarily related to optical memory devices;
- Owing to its extremely high sensitivity, the capability of detecting any signals originating from ferromagnetic nano-powders, even when the quantity of such powders does not exceed 100 cubic nanometers;
- Capability of autonomous operation regardless of external interference.

A Product Based on the Application Technology – AN OPTICAL DISC WITH ENCODING INFORMATION APPLIED BY MEANS OF NANO-IMPLANTS

The product represents any version of an optical disc used for digital information storage, within a specific volume level of which nano-implants are arranged according to a predetermined topology. Each nano-implant consists of a nano-capsule made of a magnetic material enclosed within a shell composed of a non-magnetic material.

To ensure the proper orientation of the nano-capsules, recesses corresponding to the dimensions of the nano-capsules are formed within the body of the disc prior to the operation of bonding the two halves of the disc. The nano-capsules are embedded into these recesses, after which the two halves of the disc are bonded together using existing manufacturing technology.

Such discs may be used in any optical memory storage device if the recording process has been performed without consideration of the special code. However, if the recording has been carried out using the coding system, the information can be read only on a drive equipped with a resonance micro-sensor, wherein the coordinates of the nano-implants must correspond to the coordinates of the nano-detectors.

Through this technology, large corporate clients may utilize proprietary drives installed in all of their computers together with proprietary optical discs whose nano-implant coordinates correspond to the nano-detector coordinates of the drives. Such a coding system provides complete protection of the client's information arrays against unauthorized access, theft, or other malicious activities.

A particular advantage of the above-described systems is the possibility of their direct application in a wide variety of structural and technological configurations that form components of different innovative technologies, all of which, without exception, employ elements of artificial intelligence and artificial neural networks within their management and control systems.

New Smart Manufacturing Technologies *(Waste Utilization and Regeneration of Process Solutions, Recirculation of Etching Solutions and Other Process Liquids, Conversion of Toxic Exhaust Gases into Harmless Liquids)*

Ensuring environmental safety in manufacturing technologies in accordance with applicable standards is a mandatory condition for the implementation and continued operation of such production processes.

Before environmental standards with stricter requirements regarding the concentration of pollutants in industrial waste became widely adopted, it was generally sufficient to treat waste prior to its disposal at specially designated facilities.

Today, due to the substantial tightening of environmental regulations, such treatment has become extremely costly, ultimately leading to a significant reduction in the economic efficiency of virtually any manufacturing process.

This situation has necessitated the introduction of entirely new concepts and approaches into industrial practice:

- The search for methods of regenerating production waste for the purpose of its subsequent recirculation and repeated reuse;
- The implementation of technologies for extracting heavy metals from waste streams in order to return them to the production cycle and to maintain the continuous recirculation of process solutions, thereby extending their operational service life. For example, the continuous intensive extraction of copper from etching solutions used in automatic printed circuit board and thin-film microassembly etching lines makes it possible to maintain permanent recirculation of the etching solution, completely eliminate environmental contamination by toxic copper ions, and significantly improve the economic efficiency of etching processes;

- The modification of waste composition in order to alter the properties of contaminating materials and convert such materials and their chemical compounds into harmless or substantially less harmful substances and chemical compounds.

This issue has become particularly important in integrated technological systems in which waste products consist of exhaust gas mixtures that, even in the most advanced purification systems currently available, cannot be cleaned to the desired level while maintaining acceptable operating costs.

The author proposes consideration of the following system intended for use as an alternative method of reducing the toxicity level of atmospheric emissions generated by a conventional diesel generator.

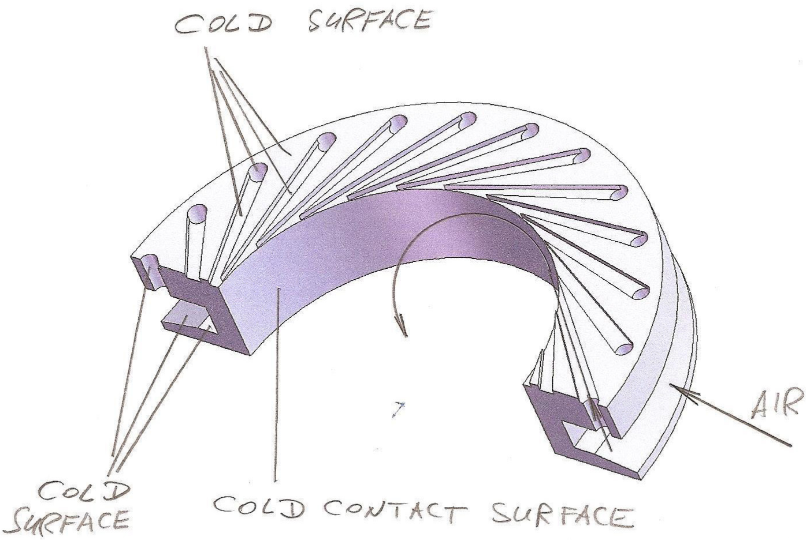

Figure 1 – Fragment of a three-dimensional model of a vortex generator incorporated into a system for the condensation of liquid from an exhaust gas stream

For the purpose of further explanation, let us assume that the discussion concerns a liquid-condensation system designed to extract liquid from the exhaust gases of a diesel generator operating on Diesel Fuel No. 5 (equivalent to purified and homogenized fuel oil).

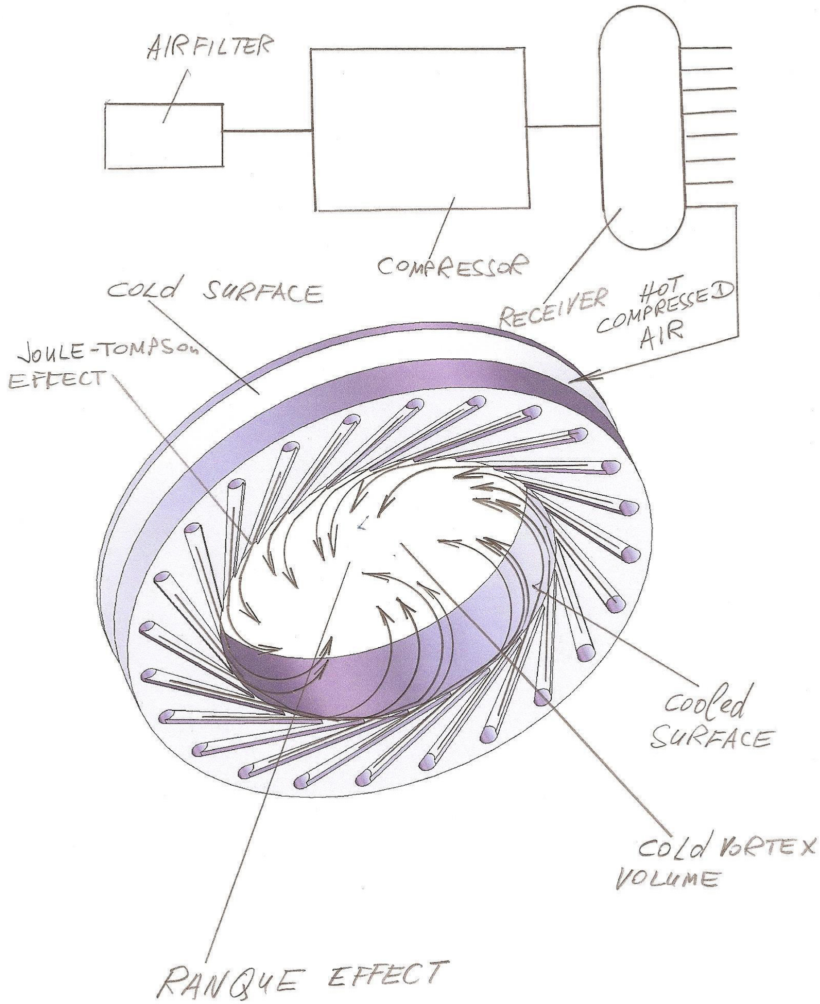

Figure 2 – Connection diagram of vortex generators to a unit consisting of an inlet filter, a compressor, and a receiver

First and foremost, it is necessary to establish the condition under which liquid will condense from the gas stream. This condition is the cooling of the gas to its dew point temperature.

The following figure presents the connection diagram and model of a vortex generator by means of which compressed gas (air) is efficiently cooled.

Due to the fact that the vortex generator initiates and forms, first and foremost, a vortex tube, a significant cooling effect occurs within it in accordance with the Joule–Thomson and Ranque–Hilsch principles. This cooling effect arises both at the periphery of the vortex tube (at the outlets of the vortex generator's injection channels) and at the center of the vortex tube as a result of the Ranque–Hilsch effect.

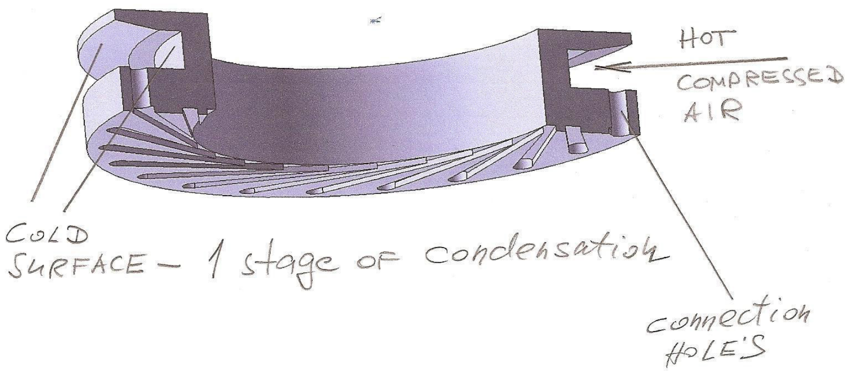

Figure 3 – Fragment of a vortex generator illustrating the details of its operating principle

This mechanism stimulates the condensation of moisture (liquid) and creates an effect of altering the structure of contaminants, after which the associated problem is substantially mitigated. As a result, the technology becomes more efficient and less costly while producing an unconventional and innovative outcome.

As can be seen from the vortex generator model, during the first stage of condensation all surfaces that come into contact with the hot compressed gas (air) are cold. Upon contact with the flow of heated compressed gas, these surfaces initiate the first stage of the condensation process.

As will be demonstrated in the following models, the liquid condensed during the first stage flows into a collection chamber, from which it can be easily removed and disposed of without causing any harm to the environment or to the technological equipment.

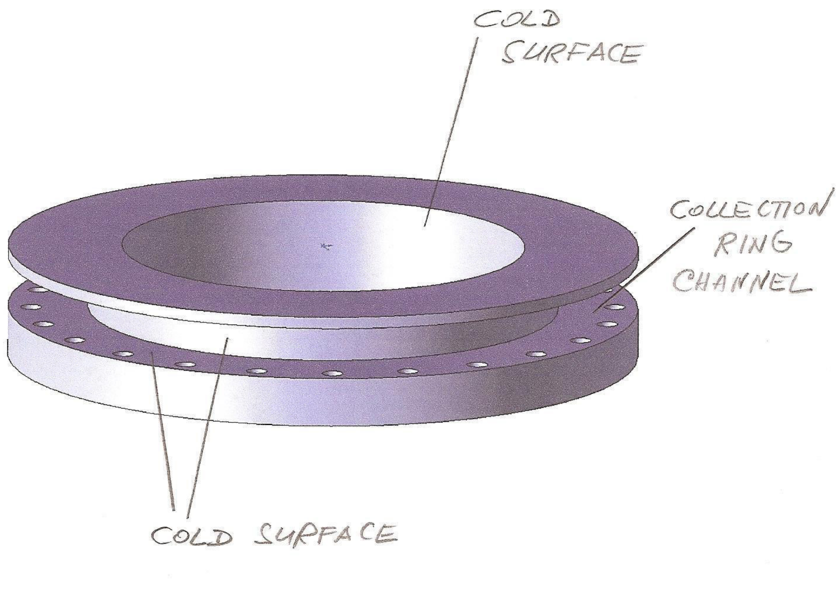

Figure 4 – Rear side of the vortex generator showing the cold surfaces that stimulate micro-condensation, which, in combination with the effects of the vortex tube, transitions into an intensive condensation phase

As can be seen from the model, despite the simplicity of its design, the vortex generator incorporates several elements that, by many criteria, may be considered innovative and embody a substantial degree of fundamental novelty.

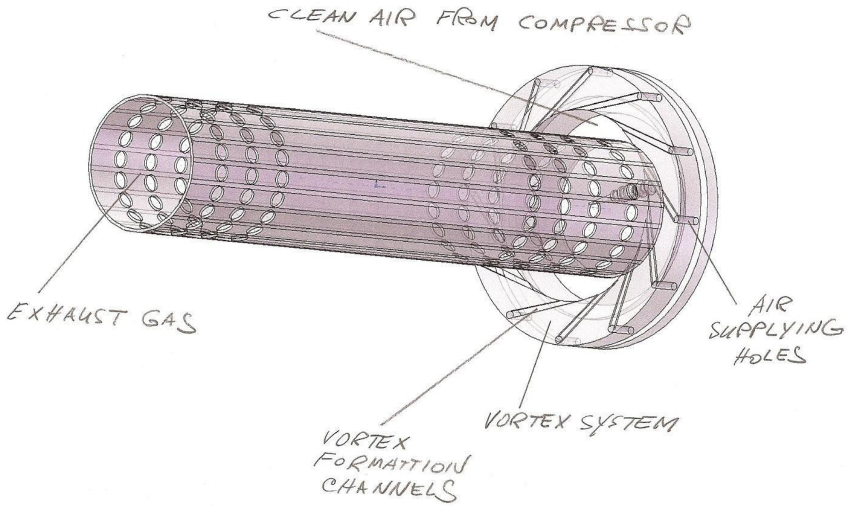

Figure 5 – Principle of interaction between the system components in a configuration where clean compressed air is used for additional cooling. The compressed air is conveyed through separate dedicated channels and does not mix with the exhaust gases at any stage of the cooling or condensation process

For the first time in the design of a vortex generator, the principle of an accumulative annular channel has been applied. The gas intended for condensation is introduced into this annular channel and then passes through transfer openings into tangential channels, from which it is injected at high velocity into a channel formed by the central internal openings of all vortex generators within the system. It is within this channel that a vortex tube is formed, consisting of multiple spirals, the number of which is equal to the number of tangential openings.

Such an aerodynamic structure of the vortex tube makes it possible to significantly intensify the heat-exchange process and ensures an active surface-condensation process on all planes and surfaces with which the spirals of the vortex tube come into contact.

In this configuration, the same design and fundamental engineering principles are employed both in stationary systems, such as those installed on diesel generators, and in mobile systems that may be utilized on diesel engines of heavy-duty vehicles.

This approach ensures effective cooling and condensation while maintaining complete separation between the cooling medium and the exhaust gas stream throughout the entire process.

When discussing Smart Manufacturing Technologies, it is important to highlight the effectiveness of the technical principle of condensing liquid from exhaust gases instead of relying on deep exhaust-gas purification methods.

This approach provides significant advantages and makes it possible not only to purify exhaust gases and substantially reduce their toxicity, but also to bind contaminants within the liquid obtained through the condensation process. As a result, disposal costs are reduced by an order of magnitude.

In addition, the energy required for liquid condensation is considerably lower than the energy required for deep filtration processes. Furthermore, the problem of disposing of spent filtration elements is substantially more complex than the disposal of the condensed liquid produced by the proposed system.

Consequently, the condensation-based approach may represent a more economically efficient and environmentally sustainable alternative to traditional deep-filtration technologies used for the treatment of industrial exhaust gases.

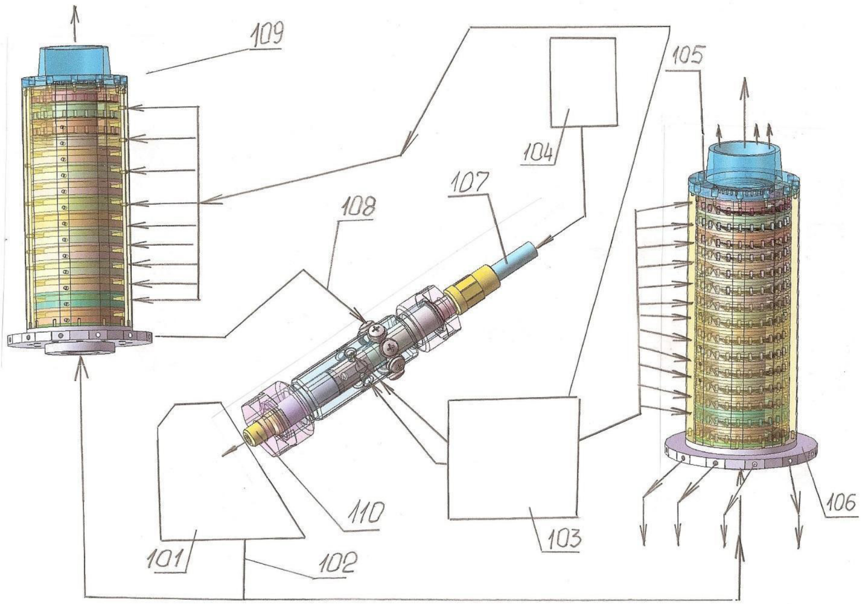

Figure 6 – Exhaust Gas Condensation System Installed on a Vehicle Diesel Engine

101 – Engine
102 – System for producing an emulsion from diesel fuel components
103 – Compressor
104 – Diesel fuel tank
105 – Condensation system
106 – Lower flange of the system connected to the engine exhaust pipe
107 – Diesel fuel inlet to the system for producing an emulsion from diesel fuel components

108 – Condensed liquid inlet to the online emulsion-production system utilizing a mixture of diesel fuel components

109 – Secondary column serving as a system for condensing liquid from exhaust gases

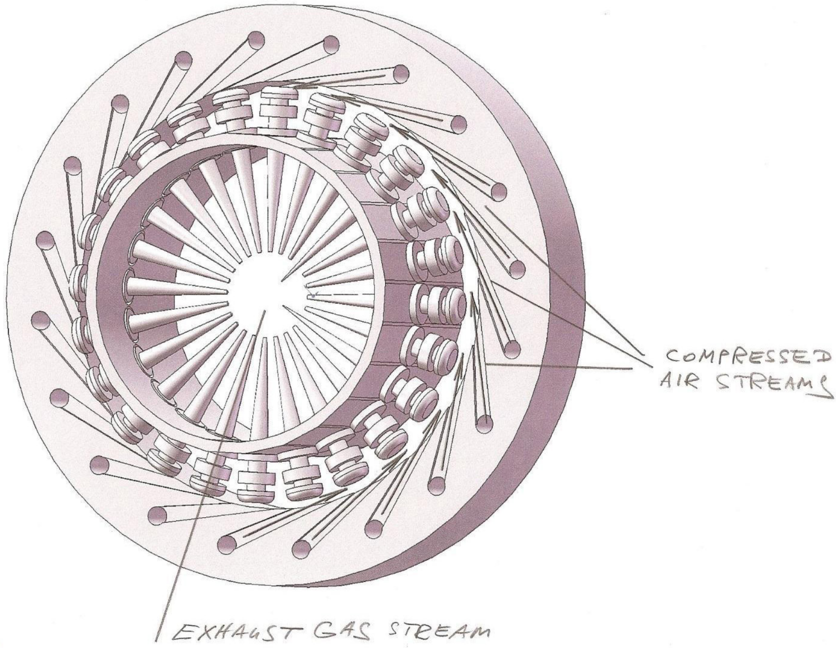

Figure 7 – Three-dimensional model of a vortex generator in which a parallel cooling operation is performed on conical reflectors installed in radial directions within a pipe through which exhaust gas is supplied vertically. On the exterior side, radiators are press-fitted onto these same reflectors. The radiators are intensively cooled first by tangential flows of compressed air, which, in the final stage of their trajectory, are transformed into the spiral flows of a vortex tube

As demonstrated by the presented three-dimensional models of various types of vortex generators featuring different structural configurations and combinations of operating systems, this design and layout flexibility makes it possible to implement such or equivalent technical solutions in numerous industrial technological complexes that generate waste in the form of exhaust gases or gaseous materials of a similar nature.

The design and functional capabilities of the vortex generators may also be applied in various fuel-system configurations intended for gaseous fuels.

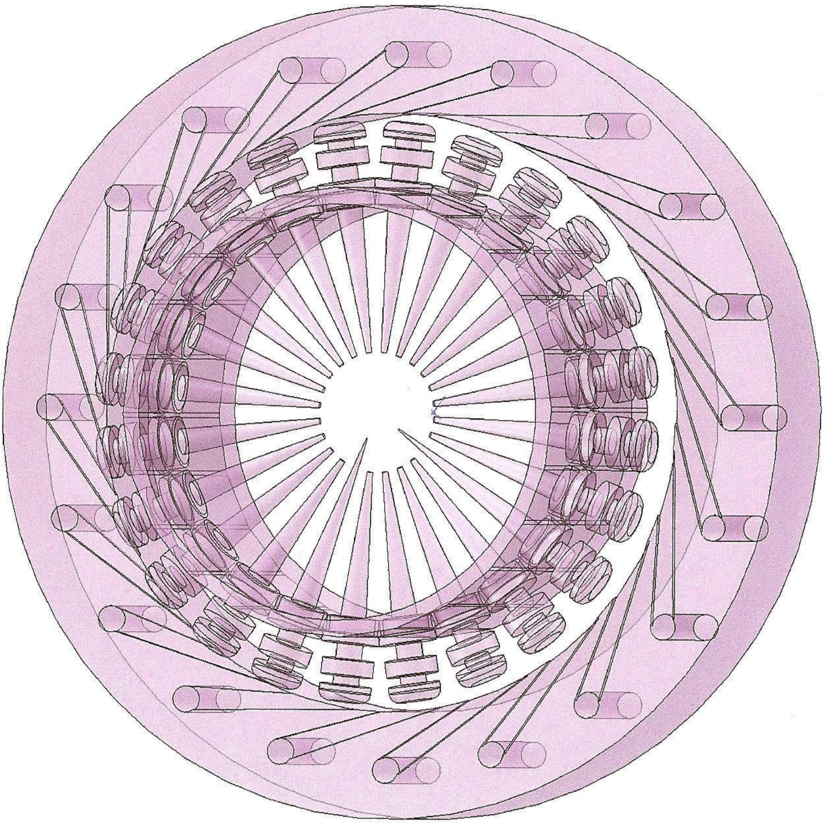

Figure 8 – Vortex generator and an activating and cooling system installed coaxially within its cylindrical reaction cavity, consisting of conical reflectors and cylindrical radiators, each radiator and reflector being positioned along the same axis

The radiators are installed along the trajectory of the vortex-tube spirals and, prior to the formation of the vortex tube itself, along the path of the tangential flows of compressed gas (air) injected into the integrated vortex-tube formation zone located coaxially with the injection channels of the vortex generator.

As a result of this arrangement, the radiators and reflectors are subjected to intensive cooling by both the tangential gas flows and the subsequently formed spiral flows of the vortex tube, thereby enhancing heat-transfer efficiency and promoting the condensation process within the system.

Such columns, or similar configurations, are generally formed from coaxially connected vortex generators and, based on the results of practical application, have demonstrated promising performance.

In general, the full potential of vortex tubes has not yet been completely explored, and the process of adapting such systems to conventional design configurations for operational exhaust-gas purification or environmentally safe exhaust-gas disposal remains the subject of ongoing research, modeling, and the development of technical concepts associated with this phenomenon.

The potential applications of vortex generators are also considerable. The fundamental operating principle of such a generator allows it to be used not only in devices intended for vortex-tube formation, but also in gas-mixture preparation systems, gaseous-fuel injection systems for combustion chambers, and various technological processes where several gases must be mixed while maintaining a high degree of mixture homogeneity.

The same principle may also be utilized, for example, in systems designed for the purification of natural gas from naturally occurring contaminants.

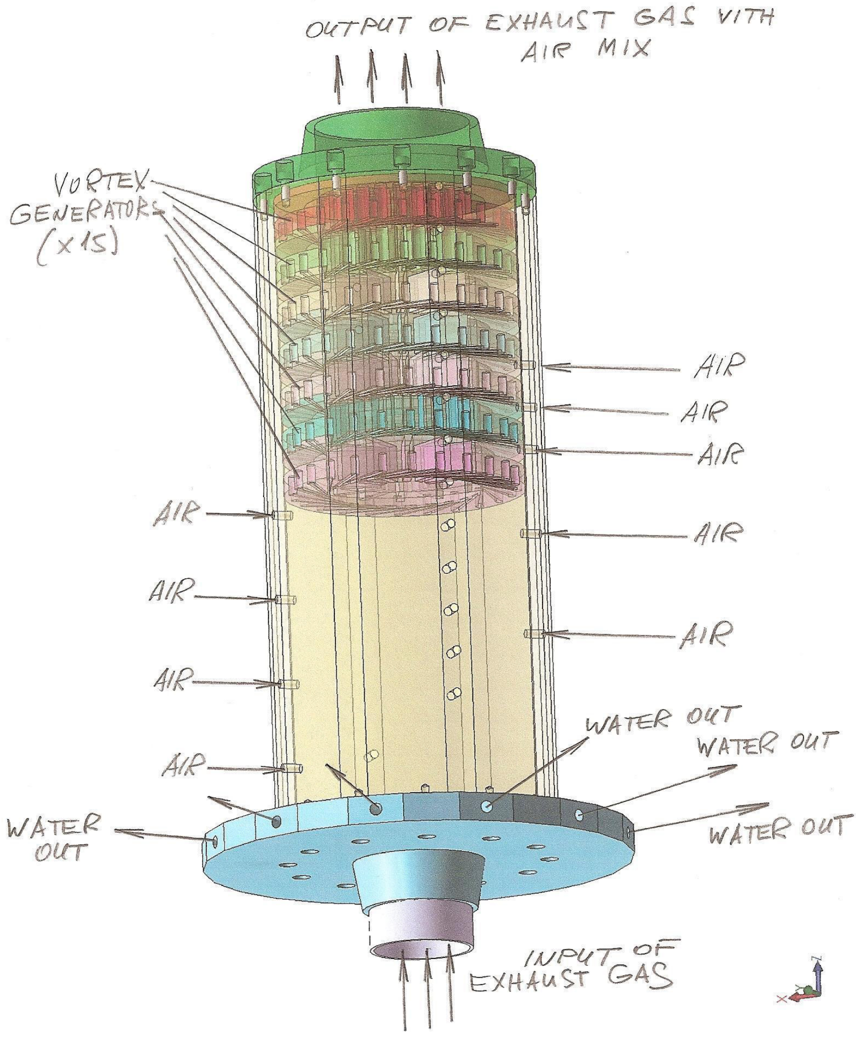

Figure 9 – Reaction column in which 15 vortex generators are installed, sharing a common reaction axis within which a vertical vortex tube is formed

Given the increasing implementation of technologies involving the mixing of coal dust with water, the vortex-generator principle may also provide an effective solution to the challenges associated with this type of vortex mixing process.

The substantial cooling potential present within a vortex tube has encouraged designers and developers to consider the use of vortex generators in systems for supplying gaseous fuels or gaseous fuel mixtures to combustion chambers, where the aerodynamic turbulent characteristics of the gas mixture influence, to varying degrees, the properties and geometry of the flame.

It is known that supplying fuel in the form of a vortex tube makes it possible to achieve a highly compact flame configuration whose shape and geometry approach those of a sphere. At the same time, the gaseous fuel undergoes significant cooling while passing through the vortex tube. As a result, combustion of the cooled fuel can substantially reduce the concentration of toxic nitrogen oxides in the exhaust gases.

Furthermore, supplying the fuel mixture in the form of a vortex tube stabilizes both the flame and its geometry, which generally has a beneficial effect on vibration levels within the combustion chamber and helps prevent deterioration and damage to the combustion-chamber lining.

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