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To cite this article: L M Generalova *et al* 2019 *IOP Conf. Ser.: Mater. Sci. Eng.* **483** 012029

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# Best available technique in the environmental management system of ceramic enterprises

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**Abstract.** The article discusses the advantages of introducing the Best Available Technique (BAT) as a set of various processes, methods and other ways to protect the environment in the ceramic industry. The article touches upon the efficiency of referring tools and methods of system of ecological management to BAT as one of the most important directions of ensuring ecological safety. The work defines that ecological safety is extremely important for development and activity of any enterprise as for profitability of production and competitiveness of the enterprise it is necessary to prove not only profitability and efficiency of its work, but also ecological safety of manufactured production. The introduction of the Best Available Technique into production is a highly effective method of increasing the level of environmental safety. The research analyzes the theoretical foundations of the concept of the BAT available in domestic and foreign sources, existing technological processes, equipment, technical methods, as well as other methods of environmental protection referred to the Best Available Technique in the ceramic industry. The article states that introducing the Best Available Technique in production involves an overall system of environmental protection measures, which achieve a significant minimization of the negative impact on the environment and population.

## 1. Introduction

In the modern world, environmental protection is one of the most urgent and global problems. The adverse impact of human activities on the natural environment has been growing at an alarming rate every year and in some cases, it has reached global proportions and is comparable to large-scale technogenic disasters. One of the most important indicators of national security in modern society is environmental security, which provides a state of protection of vital human interests, society and the environment from the possible negative impact of economic and other anthropogenic activities.

Since modern man is not ready today to abandon the products of engineering and technical design, the scientific and technological progress should be civilized and different from all previous technogenic transformations. Due to the constantly deteriorating environmental situation it is necessary to improve the legal regulation in the field of environmental safety at the government level. Environmental control and environmental monitoring are important parts of the organizational and legal mechanism, the purpose of which is to verify compliance with the requirements of environmental legislation, compliance with standards and regulations and environmental safety.

## 2. Results and Discussion

### 2.1. Development of the concept of BAT in the ceramic industry

At the end of the last century there was a change in the dominant environmental values and relations associated with the global environmental crisis as well as with the awareness of society of the urgent need to limit the negative impact of large industrial and agricultural enterprises on the environment. The change in the environmental paradigm has resulted in the creation of the concept of BAT (Best Available Technique), which has contributed to limiting the consumption of natural resources in order to preserve them for future generations.



Under the term of Best Available Technique we mean the most effective latest developments for various activities, processes and modes of operation indicating the practical feasibility of using specific technologies as a basis for established permits for emissions/discharges (pollutants) into the environment in order to prevent pollution. Otherwise when prevention is impossible, it is necessary to minimize emissions/discharges into the environment as a whole" [8]. This concept was widely used in Europe, the USA and the USSR.

Legislative environmental regulation of enterprises based on the concept of BAT was defined in the European Union in 1996 by Directive 96/61/EC «Integrated pollution prevention and control». This Directive addressed the relationship between industrial technologies and their impact on the environment. It was later replaced by Directive 2008/1/EC on integrated pollution prevention and control and subsequently by Directive 2010/75/EC «On industrial emissions and or discharges (integrated pollution prevention and control)» [8, 7]. International experience in the implementation of BAT in industrial production, considered on the base of EU Directives, was subsequently the basis for the creation and development of the concept of BAT in Russia [6].

As part of the introduction of BAT in the industrial production of ceramic products, the European Union Handbook on the Best Available Technique «production of ceramic products» was created [9]. According to this Handbook the main issues in the implementation of Directive 2010/75/EC are the following: reduction of emissions/discharges of pollutants, energy efficiency, resource conservation, minimization, disposal and recycling of waste and effective management systems [6, 8].

In 2014 by the Act of Federal Agency on Technical Regulation and Metrology from December 3-d, 2014 №192 in Russia there was the Russian Bureau of BAT created, the main activity of which was the development of information and technical guides on the Best Available Technique. Development of handbooks is carried out by leading technical working groups based on European experience as well as on the base of the analysis of resource efficiency and environmental performance of enterprises. At the same time the first domestic handbook on BAT ETS 4 is being developed and implemented in production taking into account the peculiarities of producing ceramic products in the Russian Federation. The Handbook contains a description of the processes used in the production of ceramic products, equipment, technical methods, methods of reducing a negative impact on the environment and improving energy efficiency and methods allowing to ensure resource conservation in the ceramic industry [5]. Nowadays, there are more than 30 information technology handbooks on the Best Available Technique in the Russian Federation.

## *2.2. Environmental safety in the ceramic industry as an object of scientific research*

Regarding the above statistics it is obvious that in recent years the environmental safety in the ceramic industry has been of genuine interest to domestic researchers. Close attention is paid to the disposal of waste products of ceramic production, especially ceramic bricks and tiles in the scientific research works of E. M. Averochkina, Ya.P. Molchanova, T.V. Guseva, M.V. Begak, A.V. Mironova and others [1,2,3]. Scientists consider in detail not only the problem of processing waste ceramic production, but also the prospects for the introduction of BAT reference books in the production of ceramic products as well as peculiarities of implementing the concept of the Best Available Technique in the enterprises of the Russian Federation. The problem of implementation of these technologies is discussed not only at the stage of manufacturing final products, but also at the stage of design, maintenance, creation and operation of the enterprise.

Scientists point out the fact that the technologies used must necessarily be developed on a scale that allows them to be implemented in the relevant industry in an economically and technically feasible way taking into account the relevant costs and benefits, in order to effectively achieve the necessary level of environmental protection in the whole.

The aim of these developments is to assist local authorities in implementing the best environmental technologies into the waste management system in order to minimize the negative impact on the environment.

Currently, such tools of environmental safety as best practices/means (Best Practical Means) and best practical environmental solutions/options (Best Practical Environmental Options) are widely used providing the search for methods to achieve a high level of environmental protection in the whole.

Russian scientists and specialists by the term «Best Available Technique» mean, first, best practices, methods and environmental regulations. To solve specific problems an extensive database including various technical proposals for environmental safety is formed, as well as practices for the management of processing production waste.

Besides, it was found out, that despite the active development of the process of modernization of the ceramic industry in the Russian Federation and the development and implementation of BAT in various sub-sectors of the production of ceramic products, this process is rather complicated. It is stipulated by the fact that a significant lack of criteria for categorization of objects having a negative impact on the environment, according to many environmentalists, is explained by the focus on the capacity of enterprises, and not on the negative impact in the latest research.

In addition, a clear drawback of the system of environmental safety at many enterprises of the ceramic industry is the lack of environmental services, environmental laboratories and the presence of an environmental engineer. Some of the enterprises are not willing to implement the Best Available Technique, as this only leads to improving environmental performance, but not economic, as these activities are often considered economically impracticable.

### *2.3. Environmental management system as part of the enterprise management system*

In the Russian Federation approved general methods of environmental protection for all industries of ceramic products are the methods and means of environmental management system, which are necessary for the development and implementation of environmental policy and management of environmental aspects of the enterprise management system.

Environmental aspect is a key concept of EMS allowing to correlate the enterprise activities and its interaction with the environment, which includes the following priority environmental aspects:

- emissions of pollutants into the atmosphere;
- discharges of pollutants into water bodies;
- waste formation;
- consumption of energy, raw materials [4, 5].

The key principles of EMS are pollution prevention and consistent improvement of the environment, as well as the periodic process of improving the environmental management system in order to improve the overall environmental performance consistent with the environmental policy of the organization. This process is implemented by setting environmental goals and objectives, allocating resources and distributing liability for their achievement and implementation, in particular, the development and implementation of environmental management programs.

The development of environmental management programs implies improving the practice of industrial environmental monitoring and control, including the selection, justification and organization of measurements of key parameters, because for the formulation and verification of the tasks of the EMS it is necessary to provide a system for assessing performance indicators.

The effectiveness of EMS is ensured through the development, implementation and compliance with the basic procedures necessary for the management of environmental aspects, which may include working criteria for the normal implementation of the stage, action in case of deviation from the norm or criteria for the selection of subsequent stages.

The most important component of the economic efficiency of environmental activities, enhancing the implementation of EMS, is the principle of pollution prevention. This principle is the most effective, and sometimes the only possible, as it is the prevention of negative impact on the environment by affecting the processes (the root cause) of its cause.

The above methods of pollution prevention are often efficient and cost-effective. First, it concerns organizational approaches related to the selection of raw materials, production process control, recycling or processing materials, production logistics, etc.

#### 2.4. Applying BAT in the ceramic industry

Let us consider in more detail the technological and technical solutions applicable as BAT for the industry of ceramic products in the whole.

In the field of energy consumption in the production of ceramic products improving the energy efficiency of production as a whole, as well as reducing the specific emissions of pollutants entering the air due to fuel combustion allows to reduce specific energy consumption [10]. Reduction of fuel consumption in the production of ceramic products is achieved through the introduction of BAT, which is a reduction in energy consumption using a combination of the following technological solutions and techniques:

- modernization of furnaces and dryers;
- recovery of excessive heat of furnaces, especially from the cooling zone. In this case, the excess heat of the furnace in the form of hot air can be directed to the heating of dryers for drying raw materials or semi-finished products;
- optimization of the shape, size, composition and structure of the blanks significantly increases the energy efficiency of drying and firing with the use of appropriate dryers and furnaces.

In the field of reducing emissions of pollutants into the air, reducing dust emissions in the production of ceramic products is achieved through the introduction of BAT-reduction of unorganized dust emissions using a set of technical solutions [5]:

- carrying out technological operations, accompanied by the formation of dust in a closed volume;
- equipment of mixers, crushers and feeders with protective covers and exhaust installations;
- application of storage bins of the corresponding capacity, level sensors with cut-offs and filters for cleaning of the dusty air displaced at filling of the bunker;
- remove of the dusting material using closed conveyors;
- reduction of leakages and elimination of their sources, sealing of installations;
- for bulk storage areas of raw materials:
- fencing sites bulk storage of raw materials using screens, walls or large green spaces;
- equalization of the level of unloading of raw materials with the height of the receiving area;
- reduction of the speed of unloading raw materials;
- humidification with spray systems source dusting.

In the field of reducing emissions of pollutants with waste gases during the firing of ceramic products the technology of BAT is to reduce emissions of pollutants (carbon monoxide, nitrogen oxides, sulfur, volatile organic compounds, etc.), formed during the firing of ceramic products, through the use of a set of technical solutions [5]:

- optimization of the fuel combustion process to reduce emissions of carbon monoxide and nitrogen oxides, control of the excess air ratio for the completeness of fuel combustion;
- reduction of the maximum firing temperature and its duration;
- optimization of the firing mode by regulating the rate of temperature rise in intervals of up to 400 °C (possible reduction in the rate for complete binding of fluorine and sulfur) and after 400 °C (possible increase in the rate to reduce emissions);
- replacing technological ligaments and components of the raw materials that form during firing VOCs (volatile organic compounds) on the ligaments and the parts that make up fewer VOCs or do not form them at all;

- reducing the supply of sources of pollutants, namely: the use of raw materials with a low content of sulfur and nitrogen, fluorine, chlorine or reducing the amount of raw materials with their high content.

In the field of reducing the formation of wastewater the BAT of reducing the amount of industrial wastewater in the production of ceramic products is used [11]. In this case the BAT is the reduction of water consumption and the reduction of pollutants in wastewater through the use of a set of technical solutions [3]:

- reduction of water consumption through the application of measures to optimize the process, including:

- prevention of water leakage throughout the water supply system by installing automatic valves and meters;
- installation of systems for collecting glaze and waste water from various stages of the technological process in the places of their formation;
- reuse of water, in particular repeated use of water, after appropriate treatment;
- use of wastewater treatment systems (if necessary, depending on the characteristics of the sub-sector).

For industrial wastewater returning to the mass treatment process, treatment may not be required (except in cases of high content of soluble salts in water). For industrial wastewater used for washing, additional preparation is required.

In the field of re-use of sludge is used the BAT of re-using of sludge in the production of ceramic products. The BAT is the recycling (re-use) of sludge through the application of one or more technological solutions [5]:

- re-use of sludge in the production process by adding to the molding mixture, mass or slicker with pre-treatment (averaging, separation, aging, drying, etc.) in accordance with the technological capabilities of production and formulation [12].

In the field of minimization of production waste, the following BAT is used – minimization of production waste and technological losses. The BAT is the reduction of solid waste generation through the use of a combination of the following technological solutions [5]:

- return of technological wastes (dust, scraps, battle, baked products) in production;
- use of solid waste gypsum molds and ammunition for other industries (gypsum-for the cement industry) or their own production (combat ammunition-for its production);
- replacement of plaster molds with plastic with greater turnover;
- decrease of the ratio of one pipe/fired product by applying nonsagger firing, fast firing in roller kilns and optimization of cages products;
- optimization of firing conditions, leading to the decline of marriage goods and the time of operation of kiln furniture.

In the field of noise reduction the following BAT is applied – reducing the noise impact of the production of ceramic products. The BAT is the reduction of noise by applying one or more of the following technological solutions [5]:

- sealing and proper maintenance of equipment that is a source of increased noise;
- vibration compaction of equipment, especially equipment for grinding and pressing;
- use of sound insulation of fans and blowers;
- application of low-speed fans;
- sound insulation of windows and doors;
- use of soundproof building materials in the construction and repair of industrial premises;
- carrying out noisy work only in the daytime.

### 3. Conclusion

Thus, it can be concluded that the Russian Federation is actively developing the process of modernization of the ceramic industry, as well as the development and implementation of the Best Available Technique in various sub-sectors of the production of ceramic products [13]. At the same time, it should be noted that it is permissible to classify not only technological processes, equipment, technical methods, but also other methods of environmental protection as the Best Available Technique. In this regard, quite effective are such tools and methods of environmental management system as BAT. Nowadays various Best Available Technique have already been developed, applicable for the entire industry of ceramic products in General, and for individual sub-sectors.

The optimal implementation of the environmental management system as BAT in the ceramic industry will allow to control the causes and conditions of the impact of environmental aspects, which will lead to the solution of the problem of preventing and (or) reducing the negative impact of the production organization on the environment, that is, to ensure its protection.

Practice shows that the environmental management system plays the role of a starting mechanism in the production, in which the search and application of pollution prevention approaches takes a regular and systematic character, and organizational and management decisions are implemented most successfully.

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