Ways to Eliminate Unpleasant Smelling Substances for the Environmental Safety of Meat Industry Enterprises

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Abstract. A lot of attention is being paid to the issues of safe stay of humans and other biological communities in residential and working premises, industrial and agricultural buildings. This is due to the fact that microscopic organisms, along with the destruction of building materials and products in buildings, can cause a pathological condition called Sick Room Syndrome (SBP), allergies, and sometimes mycotic infection of the lungs. In this paper, we consider the issues of improving the environmental situation in buildings of meat processing plants, by reducing the emissions of unpleasant-smelling substances in the air of the working area with the help of disinfectants "Teflex". The bactericidal effect of the drug "Teflex" is determined by the ability of guanidine derivatives to bind to the cell walls and membranes of bacteria, penetrate into the cell nucleus and inhibit cellular enzymes. The technology of treatment of premises with a solution of disinfectant using a “quasar” type sprayer and a “Clean air” installation is presented. It was experimentally revealed that in this case it is advisable to use 1,5-2,0 % solutions of the disinfectant. The use of disinfectants in such concentrations helps to eliminate unpleasant-smelling substance as a continuous source of emission, and the presence of volley emissions.

1. Introduction

Human health directly depends on the lifestyle. The quality of food, water and air that we breathe are all components of a comfortable living environment. Residents of the city spend 50-70% of their time in their apartments, and up to 80-90% of the time in closed premises, including workplaces. It is known that people within 1 hour inhale and filter through their Airways about 1 m³ of air. Mold spores contained in the air can cause a pathological condition called Sick Room Syndrome (SBP), allergies (rhinitis, bronchitis, asthma), and sometimes mycotic infection of the lungs.

2. Method of research

To determine an environmental hazard or similar risk, a combination of the toxicity index and the pollutant release index (emissions) is used.

Toxicity index. Each of the pollutants in the degree of exposure to the human body corresponds to a limit or threshold level of concentration (MPC). To determine the toxicity, a regulatory framework is required – the MPC in the air. The toxicity index is determined depending on the MPC. MPC less than 10 is the lowest index of toxicity for gases, MPC more than 500 is the highest.
The index of the issue (emission) of pollutants. The amount of released contaminant depends on the
temperature, technical characteristics of gas treatment plants, operation of technological equipment,
etc. For example, the MPC less than 10 is the lowest gas toxicity index, and the MPC greater than 500
is the highest.
In this regard, it is necessary for the existence of living communities in the premises to determine
the environmental hazard and create healthy living conditions.

3. Relevance and scientific significance of the issue
The limiting indicator of environmental hazard is contamination of the soil by pathogenic
microorganisms, and especially mycelial fungi.

Contamination of premises with mold fungi occurs in various ways. The most provable and
permanent way is the formation of colonies of fungi on walls, ceilings, under baseboards, etc. as a
result of humidification of building structures of the room during leaks, etc.

A less controlled path of contamination is the entry of fungal spores into the premises with air
flows from auxiliary rooms: flooded basements, garbage collectors located near buildings, from attics
and run-down staircases, as well as through ventilation channels from colonies that have grown on
condensate in the ventilation system itself. When" impregnating " building structures, colony-forming
units (CFU) of microorganisms are formed on the surface of the floors. First, there are
"efflorescences" in the form of changes in the color of coatings (Wallpaper, paint, marble or ceramic
tiles). Then, against this background, colonies of mycelial fungi and other bio-destructors of building
materials grow.

Mold fungi cause significant damage to materials, deeply growing vegetative mycelium in the
substrate (food, building materials) and developing in them, form an air mycelium on the surface,
which forms conidia that pollute the environment. They destroy polymer materials, paint, concrete,
plaster, brick, plastic, wood [1, 2, 3, 4, 5, 6, 7]. Therefore, it is impossible to get rid of the fungal
microflora that has already appeared by simple methods. You can wash, clean, and paint over surfaces
where visible mold colonies are located, but deep-growing spores are invisible and, over time, they
still germinate, destroying non-biocidal coatings [8]. The problem must be solved in a complex:
preventative and radical.

The existing norms of fungal air contamination in Europe are presented in table 1, and in Russia-in
table 2.

| Category                  | Fungi, CFU / m³ |  |
|---------------------------|----------------|---|
| living spaces             | Non-industrial production facilities |
| Very low level            | < 50           | < 25 |
| Low level                 | < 200          | < 100 |
| Mid-level                 | < 1000         | < 500 |
| High level                | < 10000        | < 2000 |
| Very high level           | > 10000        | > 2000 |

Table 1. Norms of fungal air contamination in Europe. (project-ESA COST 613 19930).

Pharmacies (air) according to guidelines # 3182-84

| Sampling location                     | Fungi, CFU / m³ |
|--------------------------------------|----------------|
| Aseptic block, packing room, material room | 0              |
| Cleaning room                         | up to 12       |
| Service hall                          | up to 100      |
| Microbioprom producer for Health standards | MPC, KL / m³ |
| Producer microorganism                | 500-1000       |
| Fungi of the genus Aspergillus        |                |

Table 2. Norms of fungal air contamination in Russia.
Fungi of the genus Candida: 200-1000
Fungi of the genus Penicillium: 2000-5000
Microbial aerosol of livestock and poultry production facilities according to Hygienic standards 2.2.6.709-98

- Total microbial number: 50000
- Fungi of the genus Aspergillus: 20% of the amount of microorganisms
- Fungi of the genus Candida: 0.04% of the amount of microorganisms

The threshold for human tolerance to mycelial micromycetes in residential areas is recommended to accept a level of contamination up to 500 CFU per 1 m³.

In accordance with the decree of the Ministry of labor and social development of Russia dated March 14, 1997 "on certification of workplaces by working conditions", all enterprises, regardless of their ownership forms, are required to conduct certification of workplaces by working conditions [9].

The issue of safe human stay in the workplace, as well as other biological communities, is currently receiving a lot of attention [10]. One of the legislative projects is the order of the chief sanitary doctor Filatov N. N. " on approval and implementation from September 1, 2004. Methodological recommendations for the organization of control over cleaning and disinfection of ventilation and air conditioning systems.

Since September 1, 2004, all enterprises and institutions are required to have a contract for ventilation cleaning [11].

Therefore, the meat industry enterprises should pay maximum attention to environmental problems, namely, reducing emissions of unpleasant-smelling substances into the atmosphere.

4. Purpose and objectives of the study
The purpose of this work is to study the possibility of eliminating unpleasant-smelling substances using the "Teflex" deodorant in the air of the working area.

Research problem:
- Develop a technology for treating premises with solutions of disinfectants.
- To experimentally establish the optimal concentration of disinfectants for processing areas of meat processing plants.
- Consider options with permanent and multiple sources of harmful emissions.

5. Theoretical part
For enterprises in the meat industry, air emissions of pollutants are caused by a variety of technological processes for processing raw materials of animal origin. The peculiarity of these emissions is unpleasant-smelling substances (NPS), which are organic substances suspended in the air. Sources of emissions are opalone NIP-fat separation plants, thermal office of sausage shop, a by-products plant, as well as volley emissions during the cleaning of the grease traps. NPS emissions do not always exceed the MPC, but are easily distinguishable in the air by their specific smell, so their elimination occurs in small amounts.

One of the ways to spread NPS is their movement through air ducts that provide ventilation of the working and household areas.

To eliminate unpleasant smelling substances, the following methods and means are used: mechanical cleaning methods; ozonation; UV treatment, disinfectants; the use of "Teflex" disinfectant to eliminate NPS.

Technical methods for eliminating NPS are based on neutralization of volatile chemicals, their dilution or filtration.

Recently, along with filters, ozone and ultraviolet light, various disinfectants have become most common. They have bactericidal, cleaning and deodorizing effects, successfully eliminate pathogens and NPS. Also, the great advantage of using disinfectants is their availability and low cost. The main active substances of dezskredstv: Quaternary ammonium compounds (H) (Degmin, Cationate-10, Maxi-
DEZ, Bianol, Alaminol); Guanidine compounds (Teflex, TM-aseptodine); Amines and aromatics; Organic acids; Surface-active substances (surfactants) (Sintimid-5, OP-7, OP-10); Alkali; Contains microorganisms (Tamir and others); Chlorine (Dechlorination, Trihlorizotsianurovaya acid, LIPOSTABIL, etc.); Amine-containing (Superacid) [12].

The problem of eliminating NPS, as well as pathogenic microorganisms, is effectively solved with the help of Teflex technologies and drugs developed by Soft-Protector CJSC. The preparations used for the creation of "Healthy housing" meet the requirements of environmental safety, which makes them competitive and attractive even in the Western market.

This problem is effectively solved with the help of Teflex technologies and preparations developed by Soft-Protector CJSC. The preparations used for the creation of "Healthy housing" meet the requirements of environmental safety, which makes them competitive and attractive, including in the Western market. Teflex, created on the basis of guanidine polymers, solves the problem of fighting microorganisms, i.e. it is an antibacterial and antiviral polymer preparation. The use of the drug Teflex allows to eliminate the problems of pathogenic effects of microorganisms on the human body and animals, ensuring the duration of action on pollutants [8, 12].

The bactericidal effect of the drug Teflex is determined by the ability of guanidine derivatives to bind to the cell walls and membranes of bacteria, penetrate into the cell nucleus and inhibit cell enzymes [13].

The sequence of processes leading to cell death includes: adsorption of the biocide molecule on the cell surface; diffusion of the sorbed molecule through the cell wall; binding of the diffused molecule to the cytoplasmic membrane; destabilization or destruction of the cytoplasmic membrane; isolation of cytoplasmic components from the cell; cell death.

![Figure 1. Bactericidal effect of Teflex.](image1)

The ability to bind to membranes is mainly determined by the presence of positively charged groups in the macromolecule, in particular, Quaternary ammonium groups and the presence of a negative charge on the cell surface due to the phosphate groups of lipids, as well as sialic and teichoic acids.

![Figure 2. The chemical composition of Teflex.](image2)

The mechanism of interaction of a biocidal polymer with microbial membranes is as follows. According to the calculations, each microbial cell interacts with 0.00000006 micrograms of polymer, and its structure does not significantly affect the amount of the bound substance. Upon contact with the cell, the negatively charged groups on the cell membrane initially interact electrostatically with the polymer molecule, which leads to the reorientation of the molecule and the introduction of its charged
fragments into the lipid monolayer of the membrane. The macromolecule cooperatively binds to a large number of membrane phospholipid molecules, causing the negative charge of their polarity to be neutralized. The resulting complex is stabilized by a strong hydrophobic interaction of the alkyl chains of phospholipids fatty acids, which leads to a change in the electrostatic and hydrophobic interactions that stabilize the membrane, and a weakening of the lipid-lipid interactions. Another consequence of sorption is a violation of the barrier and transport functions of the membrane. Further penetration of the hydrophobic fragment into the non-polar part of the cell membrane leads to its expansion and to a violation of the vandervaals interaction between lipid molecules. As a result, first the permeability changes, and then the integrity of the membrane, which is fragmented and destroyed.

The effectiveness of the biocide is largely determined by the nature of the microorganism. For example, against staphylococci, the effect is determined by the presence of Quaternary ammonium bases in the polymer. The drug against tuberculosis is more effective if it has unsaturated bonds. Under these conditions, the presence of a guanidine group in the polymer, which combines both an amino group and a double bond, makes polymer preparations of this type promising for fighting a wide range of microorganisms.

Teflex disinfectant from soft protector CJSC is a clear water solution of light yellow color, the formation of a precipitate is allowed. The composition of the drug as an active substance (DV) includes polyhexamethylene guanidine hydrochloride 10%. In addition, the product contains non-ionic surfactants and other functional additives. The activity index of hydrogen ions (pH) is 7.0 ± 1.0.

The product does not cause metal corrosion and according to the parameters of acute toxicity according to GOST 12.1.007-76 when administered into the stomach and applied to the skin, it belongs to the 4th class of low-hazard substances. On the treated surfaces, a barely noticeable film remains, providing a residual antimicrobial effect. Due to its low volatility, the product is not dangerous when exposed to inhalation [14]. Previously, this drug was not used in the meat industry.

6. Experimental studies and their analysis
On the basis of the experimental production of the Federal scientific center for food systems named after V. M. Gorbatov” of the Russian Academy of Sciences and in the vivarium room, experiments were conducted on the use of Teflex deodorant for the elimination of NPS. The elimination of unpleasant-smelling substances was carried out using an aerosol method using 0.7-3% solutions of dezredstvo with a ”quasar” type sprayer and a ”Clean air” installation. Processing of premises was carried out in the absence of laboratory animals and people. In the course of the experiment, the concentrations of the working solution used and the concentration of the disinfectant in the air of the working area were determined. The duration of treatment is determined, which allows to completely eliminate the NPS. The treatment modes shown in tables 3-5 are recommended to eliminate NPS. From the results of the study, it follows that when air is treated with a ”quasar” type sprayer in the vivarium room, with minor concentrations of the drug, it is possible to eliminate NPS for 5 days (table 3).

Table 3. treatment Modes for the premises containing laboratory animals without a constant source of NPS release with solutions of "Teflex" at an air temperature of 26°C.

| The initial intensity of the smell, score | Concentration of the disinfectant solution in the air, ml/m³ | Amount of solution used, ml | Amount of the disinfectant solution used, ml | Duration of elimination of NPS, hour |
|----------------------------------------|---------------------------------|-----------------------------|---------------------------------|----------------------------------|
| 5                                      | 0.11                            | 200 ml solution             | 1.5%                            | 3.0                              | 120                              |

As can be seen from the data presented in table.4 to eliminate NPS, it is advisable to use 1.5-2.0% solutions of a disinfectant.
When conducting tests on the use of the preparation "Teflex" at the experimental production "Experimental plant of canned sausage and culinary products", the use of a 2% solution of the disinfectant "Teflex" is also shown. The volume of the processed room was 56 m$^3$. To spray the Teflex disinfectant, a clean air unit with two spray nozzles was used.

**Table 4.** Treatment modes of premises containing laboratory animals with a constant source of NPS release with solutions of Teflex disinfectant at air temperature 26$^\circ$C.

| The initial intensity of the smell, score | Concentration of the disinfectant solution in the air, ml/m$^3$ | Amount of solution used, ml | Amount of disinfectant solution used, ml | Duration elimination of NPS, hour |
|-----------------------------------------|---------------------------------------------------------------|-----------------------------|------------------------------------------|---------------------------------|
| 5                                       | 0.3                                                           | 500 ml of 1.5% solution     | 7.5                                      | 90.0                            |
| 5                                       | 0.4                                                           | 500 ml of 2% solution       | 10.0                                     | 100                             |
| 4                                       | 0.5                                                           | 500 ml of 2.5% solution     | 12.5                                     | 42.5                            |
| 4                                       | 1.0                                                           | 1000 ml of 3.0% solution    | 30.0                                     | 72.0                            |
| 4                                       | 1.9                                                           | 1000 ml of 5.0% solution    | 50.0                                     | 68.5                            |

**Table 5.** Treatment modes of the experimental production facility "Experimental plant of canned sausage and culinary products" to eliminate salvo emissions of NPS at the initial intensity of the smell of NPS - 5 points.

| Air temperature, $^\circ$C | Concentration of the disinfectant solution in the air, ml/m$^3$ | Amount of solution used, ml | Amount of disinfectant solution used, ml | Duration elimination of NPS, min | The final intensity of the smell, score |
|---------------------------|---------------------------------------------------------------|-----------------------------|------------------------------------------|---------------------------------|----------------------------------------|
| 16                        | 0.82                                                          | 2300 ml of 2% solution      | 46.0                                     | 40                              | 2                                      |
| 14                        | 0.50                                                          | 1300 ml of 2% solution      | 26.0                                     | 20                              | 0                                      |
| 18                        | 0.40                                                          | 1500 ml of 2% solution      | 30.0                                     | 40                              | 0                                      |

To eliminate salvo emissions of NPS, it is advisable to use 2% solutions of the disinfectant "Teflex", since they have an aseptic effect.

Thus, the use of "Teflex" allows you to eliminate NPS both with a constant source of emission of SV, and in the presence of salvo emissions.

7. Conclusions

It is shown that mold fungi cause significant damage to materials, deeply growing vegetative mycelium in the substrate, they destroy paint, concrete, plaster, brick, plastic, wood.
In addition to biodegradation, mold spores contained in the air can cause a pathological condition called sick room syndrome (SBP), allergies (rhinitis, bronchitis, asthma), and sometimes mycotic infection of the lungs.

The Limiting indicator of environmental hazard is contamination by pathogenic microorganisms, and especially mycelial fungi, while the threshold of human tolerance to mycelial micromycetes in residential premises is recommended to accept a level of contamination up to 500 CFU per 1 m$^2$.

The paper presents the results of a study to improve the environmental situation of the working area in buildings by eliminating unpleasant-smelling substances with the help of Teflex disinfectants.

The technology of treatment of premises with a solution of disinfectant using a "quasar" type sprayer and a "Clean air" installation is Presented.

It has been Experimentally established that the use of disinfectant in 1.5 – 2.0% concentrations allows you to eliminate unpleasant-smelling substances with a constant source of emission, and in the presence of salvo emissions.

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