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HAZARDOUS SUBSTANCES: CLASSIFICATION, IMPACT, AND PROTECTIVE MEASURES IN THE CHEMICAL INDUSTRY

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Annotation: The article investigates hazardous substances, their classification, and protective measures against their impact in chemical industry settings. The introduction highlights the health risks posed by chemical substances during production, noting their potential to contaminate workplace air, skin, and surfaces. According to GOST 12.1.007, hazardous substances are classified into four hazard classes based on an analysis of indicators such as maximum permissible concentration (MPC), median lethal dose (LD50), and inhalation poisoning probability coefficient (CVIO). The methods involve analyzing standards and toxicity metrics, as well as examining pathways of substance entry into the body (respiratory system, gastrointestinal tract, skin). The results show that acute poisoning occurs at high concentrations, while chronic poisoning develops from prolonged accumulation of substances like lead and mercury.

Keywords:hazardous substances, toxicity, hazard classification, MPC, acute poisoning, chronic poisoning, chemical industry, occupational safety.

Introduction: During production processes in chemical enterprises, workers come into contact with chemicals in various forms. These substances can be as preliminary, intermediate, additive or final products, as well as in the form of gases, vapors, liquids, dust, mist or aerosols [1].

These substances can contaminate the air, clothing and skin in the workplace, as well as the surface of walls, floors and equipment, causing serious harmful effects on human health. Gost 12.1.007 " harmful substances. In accordance with the standard" classification and general safety requirements", a harmful substance is defined as a substance that can cause production injuries, occupational diseases or deviations in health when safety requirements are violated in contact with the human body. This effect poses a threat not only to the current generation, but also to the long-term health of subsequent generations identified by modern methods [2].

In industrial conditions, harmful substances can cause acute and chronic poisoning, depending on their properties and conditions of action (concentration, dose, time). Acute poisoning occurs as a result of accidents, technological conditions or violations of safety requirements, and often develops immediately after contact with substances or after a latent period (6-8 hours to several days). In such cases, harmful substances enter the body in high quantities, for example, tens or hundreds of times higher than the maximum permissible concentration in the air of the workplace. Chronic poisoning, on the other hand, occurs as a

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result of the accumulation of substances that enter the body in small quantities, but for a long time.

This article aims to present research results on the classification of harmful substances, the mechanisms of their action on the human body, the assessment of the level of risk and ensuring safety in chemical enterprises[2-3]. The goal is to determine effective methods of protection against harmful substances in industrial conditions and draw conclusions on measures to reduce their negative consequences.

Methods: Study GOST 12.1.007 "harmful substances. Classification and general safety requirements" and gost 12.1.005 are based on standards such as "general sanitary and hygienic requirements for workplace Air" [3]. A number of indicators have been analyzed to classify harmful substances and determine their level of danger. These include:

1. The maximum permissible concentration (MPC) in the workplace air is the amount of non — health-damaging substance during the 8-hour daily work hours (no more than 41 hours per week), expressed in mg/m^3.
2. The average lethal dose (DL50) when administered to the stomach is a single dose, mg/kg, which causes 50% of animal deaths.
3. The average lethal dose (DL50) when applied to the skin is a dose that causes 50% of animal deaths when applied once on the skin, mg/kg.
4. The average death concentration in the air (CL50) is a concentration, mg/m^3, that causes 50% of animal deaths after 2-4 hours of respiratory exposure.
5. The coefficient of probability of respiratory poisoning (CVIO) is the ratio of MPC to CL50 at 20°C.
6. Acute and chronic exposure zones-the acute zone is calculated as the ratio of mean lethal concentration to minimum exposure concentration, while the chronic zone is calculated as the ratio of minimum harmful concentrations in long-term exposure[4].

These indicators were systematized on the basis of Table 1 and became the basis for the classification of harmful substances into four risk classes. The study also examined the toxicity of substances, the pathways of entry into the body (respiratory system, gastrointestinal tract, skin), types of joint effects (positive synergy, negative synergism, unilateral and independent effects).

In assessing safety requirements, GOST 12.3.002 "production processes. General safety requirements " based on technological approaches were considered. These approaches include the replacement of harmful substances with low-risk substances, closed-cycle technologies, automation, monitoring, and waste treatment.

Results: adopted a formal classification of the dangers of harmful substances according to the degree of exposure to the human body[3].

Harmful substances are divided into four risk classes according to GOST 12.1.007:

1-extremely dangerous substances;
2-extremely dangerous substances;
3-moderate hazardous substances;
4-low-risk substances.

The hazard class of harmful substances is determined by the standards and indicators shown in the table.

1-table

Score	Standards for risk class

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	1	2	3	4
Maximum permissible concentration of harmful substances in the air of the working area (MPC), mg/m³	Less than 0.1	0,1 - 1,0	1,1 - 10	More than 10.0
Moderate lethal dose when administered to the stomach, mg / kg	Less than 15	15-150	151-5000	More than 5000
Moderate lethal dose when applied to the skin, mg / kg	Less than 100	100-500	501 - 2500	More than 2500
Average mortality concentration in the air, mg/m³	Less than 500	500 - 5000	5001-50000	More than 50000
Probability of respiratory poisoning coefficient (POI)	b more than 300	300-30	29-3	Less than 3
Acute zone	Less than 6	6,0-18,0	18,1-54,0	More than 54.0
Chronic zone	Less than 0.1	10,0-5,0	4,9-2,5	Less than 2,5

The risk class of each substance is determined by the highest risk indicator. For example, if the MPC of a substance is 0.1 mg/m³, but DL50 (stomach) is 200 mg/kg, it is Class 3 rather than Class 1. Harmful substances can enter the body through the respiratory system, gastrointestinal tract or skin. Access through the respiratory tract is the fastest and most dangerous route, depending on the solubility of the substance in water and the rate of absorption in the blood. Entry through the gastrointestinal tract occurs as a result of improper intake or hygiene violations, while through the skin, lipid and water-soluble substances pose a high risk. While positive synergy (e.g. chlorophos and vinylphosphate) increases toxicity in the combined effect, negative synergism (sulfur dioxide and chlorine) reduces it [5].

The chemical structure affects toxicity: an increase in the number of unsaturated contacts, the addition of hydroxyl or halogen groups increase toxicity, while the number of atoms in the molecule and the increase in isomers decrease it. Industrial dust is divided into organic, inorganic and mixed species, up to 5 microns of particles accumulate in the lungs, causing diseases such as pneumoconiosis. Security requirements include closed technologies, automation and monitoring based on GOST 12.3.002 [5-6].

Harmful substances enter the body in three ways:

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The respiratory system is the fastest and most dangerous route, absorbed in the form of gases, vapors, dust and fogs. The solubility of the substance in water and the rate of absorption in the blood affect this process. In the Chemical Industry, 90% of poisoning occurs through the respiratory tract;

Gastrointestinal tract-occurs as a result of improper reception or violation of hygiene rules (eating at work, smoking). Lipid-soluble substances (phenols, cyanides) enter the blood from the oral cavity, but gastric and liver barriers can reduce absorption;

Skin-lipid and water-soluble substances pose a risk, especially if they have high toxicity. Aromatic nitro-and amino acids, phosphororganic insecticides and chlorinated hydrocarbons cause skin poisoning.

Types of joint effects:

Positive synergy-one substance increases the toxicity of the other (e.g. chlorophos and vinylphosphate, carbon four chloride and ethylene dichloride);

Negative synergism-one substance reduces the effect of the other (sulfur dioxide and chlorine);

One-sided effect-substances affect the same system, the total effect is equal to their sum;

Independent effect-substances are not related to each other by acting on different systems (benzene and irritating gases) [6-7].

Chemical structure affects toxicity:

1. An increase in the number of unsaturated contacts increases toxicity (ethane < ethylene < acetylene).

2. An increase in the number of atoms and isomers reduces toxicity (benzene > toluene).

3. Ring closure increases toxicity (cyclopropane > propane).

4. The addition of a hydroxyl group increases toxicity (phenol > benzene).

5. Halogen and nitro groups promote toxicity (methane < chloroform).

Industrial dust is divided into organic (animal, plant, plastic), inorganic (metal, mineral) and mixed types. Up to 5 microns of particles accumulate in the lungs, causing diseases such as pneumoconiosis (silicatosis, asbestos). Safety requirements (GOST 12.3.002) include closed technologies, automation, waste treatment and monitoring[7].

Discussion: The classification of harmful substances and the analysis of their mechanisms of action are important in ensuring safe working conditions in chemical enterprises.

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While acute poisoning develops rapidly as a result of contact with highly concentrated substances, chronic poisoning is caused by substances accumulated in the long — term effect (lead — in bones, Mercury — in the kidney, cadmium-in the liver). When determining a risk Class, actual conditions (concentration, dose, time) in addition to toxicity are taken into account, which is an effective approach to real-world risk assessment.

The high risk of entry through the respiratory system indicates the need for strict control of the MPC. While MPC should not harm health in 8 hours of daily work, it is updated every 3-5 years based on studies on worker health (for example, vinyl chloride has been reduced from 30 mg/m³ to 5 mg/m³). The combined effect, specifically positive synergy, increases toxicity and poses additional risks. Alcohol, for example, promotes poisoning with aniline and Mercury.

Chemical structure and physical properties (volatility, solubility) determine toxicity. For example, mercury vapor in a gaseous state is more dangerous than liquid mercury because it enters the body easily. Industrial dust causes occupational diseases such as pneumoconiosis, especially when particles up to 5 microns accumulate in the lungs, causing fibrosis or lung cancer.

Conclusion: This article summarized the results of a study on the classification of harmful substances in chemical enterprises, their impact on human health and protective measures. Based on the Gost 12.1.007 standard, noxious substances were divided into four risk classes, a classification determined by analysis of the maximum permissible concentration (MPC), average lethal dose (DL50) and other indicators. The study showed that substances enter the body through the respiratory system, gastrointestinal tract and skin, in which the respiratory tract is the most dangerous. While acute poisoning develops rapidly at high concentrations, chronic poisoning is caused by prolonged accumulation of substances such as lead, mercury. Chemical structure and physical properties are the main factors that determine toxicity, and combined effects (e.g. positive synergy) increase risk. Industrial dust, on the other hand, causes occupational diseases such as pneumoconiosis. To ensure safety, MPC control, closed technologies and constant monitoring are necessary. The results of the study confirmed the importance of technological and preventive measures to minimize risk in the chemical industry.

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