

Characteristics of the Effect of Hydrogen Sulfide on the Human Body and Measures of Assistance to the Victied

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ABSTRACT

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Mini Review

Section 1

Principles of hygienic regulation of air pollutants for the prevention of risks to the health of workers. The formation of risks to the health of workers in contact with harmful substances of a chemical nature is determined by their nature of adverse effects on the human body, including the level of toxicity (i.e., the ability to disrupt the functioning of the leading systems of the body), the duration and intensity of exposure, taking into account the multiplicity of exceeding the maximum allowable concentrations (MPC) in the air of the working area: maximum one-time (MRK), and / or medium-shift (SSC), justified in specially conducted scientific research and officially approved. The results of determining the class of hazard (harmfulness) of working conditions make it possible, considering the length of service in contact with a given air pollutant in the working area, to predict the formation of a clinical picture of acute or chronic poisoning (disease) of an employee and to implement appropriate measures to protect his health. The guiding regulatory and methodological documents (NMD) when performing such studies in Russia are Guideline R 2.2.2006-05 (p. 1.18, p. 1.26, etc.); R 2.2.1766-03 "Guidelines for risk assessment for the health of workers. Organizational and methodological foundations, principles, and criteria"; other regulatory and methodological documents (NMD). Considering the relevant NMD positions, one should approach the interpretation of the adverse effects on the body of workers of the combined effect of a mixture of hydrogen

sulfide with C1-5 class hydrocarbons, assessed, for example, in this case, as corresponding to hazard class 2. In accordance with the request received, we set out in sufficient detail information materials on the characterization of the danger / hazard to human health of hydrogen sulfide and its mixture with hydrocarbons.

Section 2

Hydrogen sulfide: properties, conditions of formation, danger to human health (workers and the public).

Properties of Hydrogen Sulfide

Hydrogen sulfide (H₂S) under normal conditions: a colorless gas with an unpleasant smell of rotten eggs; very toxic: acute human poisoning occurs already at concentrations in the ambient air: from 0.2-0.3 mg / l; concentration over 1m/l is fatal. Hydrogen sulfide is highly soluble in water. The range of explosive concentrations of hydrogen sulfide in a mixture with air is quite wide and ranges from 4 to 45%. So, for example, in the sewer system, the concentration of hydrogen sulfide sometimes reaches 16%.

The Danger of Hydrogen Sulfide to Humans

Hydrogen sulfide is a very toxic gas, has a hazard class 3, acts directly on the nervous system. Each person should understand the importance of the following recommendation: "Be sure to consider the fact that hydrogen sulfide is dangerous whenever you smell it distinctly" (i.e., "rotten" eggs smell), since hydrogen sulfide has the

property of “dulling” the sensitivity of the olfactory nerve, due to which the affected person ceases to distinguish the presence of toxic hydrogen sulfide vapors in the surrounding air. Therefore, hydrogen sulfide intoxication can occur suddenly. In the atmospheric air, the lethal concentration of hydrogen sulfide is extremely low: 0.1%, but nevertheless, such an amount of hydrogen sulfide is enough to lead the victim to death in 10 minutes. In the case of an increase in this concentration, the death of the victim occurs instantly, after the first breath. With severe hydrogen sulfide poisoning, the most noticeable symptoms are pulmonary edema, convulsions, nerve paralysis, followed by coma.

When the content of hydrogen sulfide in concentrations lower than 0.02%, the symptoms of poisoning, although not fatal, are unpleasant: dizziness, headache, nausea. Persons who work for a long time in contact with a pollutant, or who live near plants with hydrogen sulfide emissions, develop signs of so-called chronic poisoning. Below is a link to the regulatory and methodological document on the values of MPC of harmful substances in the air of the working area. Source: SanPiN 1.2.3685-21 and extract from it. Decree of the Chief State Sanitary Doctor of the Russian Federation of February 13, 2018, N 25 On the approval of hygienic standards GN 2.2.5.3532-18 Maximum permissible concentrations (MPC) of harmful substances in the air of the working area (together with GN 2.2.5.3532-18. Hygienic standards ...) (Registered in the Ministry of Justice of Russia on April 20, 2018, N 50845)> Appendix. GN 2.2.5.3532-18. Maximum allowable concentrations (MAC) of harmful substances in the air of the working area. Hygienic standards>II. Maximum allowable concentrations (MAC) of harmful substances in the air of the working area> Table. Maximum allowable concentrations (MPC) of harmful substances in the air of the working area: extract from positions 710 and 711:

Item 710: Dihydrosulfide (hydrogen sulfide, hydrogen sulfide): H₂S No. CAS 7783-06-4); code 333, pairs, class 2, O. MPC for hydrogen sulfide in the air of the working area - 10 mg / m³, p., class 2. (Hazard class), O (acute action).

Item 711: Dihydrosulfide mixture with C1-5 hydrocarbons (hydrogen sulfide in a mixture with C1-5 hydrocarbons) CAS No. (not specified), MPC - 3 mg/m³; couples, grade 2, O (acute action).

Additional Information

MPC of Hydrogen Sulfide (H₂S) in the Air of Populated Areas

Average daily 0.008 mg/m³ (GN 2.1.6.1338-03 “Maximum Permissible Concentrations (MPC) of Pollutants in the Atmospheric Air of Populated Areas”). A noticeable smell of hydrogen sulfide in the atmospheric air is observed at a concentration of hydrogen sulfide in the range: 1.4 - 2.3 mg/m³; significant odor at 4 mg/m³; heavy smell - at 7-11 mg/m³.

Section 3. Toxicology of Hydrogen Sulfide (H₂S) and its Mechanism of Action

Hydrogen sulfide is very toxic. Inhalation of air with a low content of hydrogen sulfide causes dizziness, headache, nausea, whereas, at a significant concentration, it leads to coma, convulsions, pulmonary edema, and even death. At high concentrations, a single inhalation may cause immediate. With a less significant content in the air, the victim usually develops a convulsive-coma form of intoxication, after which a pronounced motor excitation is characteristic. At the same time, it is possible to develop severe inflammation of the airways up to the development of pulmonary edema. With the timely implementation of the necessary therapeutic measures, poisoning usually ends in a complete recovery of the victim.

Section 4. Some Information about the Sources of Hydrogen Sulfide Formation

In nature, hydrogen sulfide is quite rare in the composition of associated petroleum gases; natural gas; in volcanic gases, in dissolved form - in natural waters (for example, in the Black Sea, water layers located deeper than 150-200m contain dissolved hydrogen sulfide). Hydrogen sulfide is also found in crude oil. In the body, hydrogen sulfide is formed during the decay of proteins, but only those that contain sulfur-containing amino acids in their composition: methionine and / or cysteine. A small amount of hydrogen sulfide is found in the intestinal gases of humans and animals. Under production conditions, the release of hydrogen sulfide is possible during the decay of organic substances; extraction and processing of high-sulphurous oil; in chemical laboratories; at enterprises producing viscose fiber, sulfur dyes, matches, etc. High concentrations of hydrogen sulfide can be found in faecal household and some industrial wastewater, such as sugar beet, breweries and tanneries. It is these circumstances that explain the cases of severe acute poisoning during the repair and cleaning of the sewer network or cesspools. Chronic intoxication with hydrogen sulfide has been studied relatively little. Objective signs of the development of chronic intoxication with hydrogen sulfide in a person with an appropriate history (i.e., the presence of prolonged contact with a source of hydrogen sulfide) can include anemia, frequent bronchitis, intestinal dysfunction, vaso-vegetative syndrome, trembling.

Section 4. Human Toxicity Data for Hydrogen Sulfide

Hydrogen sulfide is very toxic. Inhalation of air with a low content of hydrogen sulfide causes dizziness, headache, nausea, vomiting, and at a significant concentration leads to coma, convulsions, pulmonary edema, and death. At high concentrations, a single inhalation can cause instant death. When inhaling air with low concentrations, a person quickly adapts to the unpleasant smell of “rotten eggs”, and it ceases to be felt. There is a sweetish metallic taste in the mouth [34]. When inhaling air with a high concentra-

tion of hydrogen sulfide, the smell almost immediately ceases to be felt due to paralysis of the olfactory nerve. The odor threshold for hydrogen sulfide (concentrations at which an odor begins to be felt) according to the World Health Organization (Air Quality Guidelines for Europe) is 0.007 mg/m³. In the Russian Federation, the maximum permissible one-time concentration of hydrogen sulfide in the atmospheric air (MACm.r) is set at the level of the odor threshold and is 0.008 mg/m³. It is important to emphasize that the concentrations of hydrogen sulfide in the air, at which reversible reactions begin in sensitive groups of the population, are significantly higher than the odor threshold. In the World Health Organization air quality guidelines for Europe, the recommended hydrogen sulfide value at which the first reversible signs of hydrogen sulfide exposure (eye irritation) may occur is 0.15 mg/m³ - 18.75 times the odor threshold. According to a separate WHO report on studies of the effects of hydrogen sulfide on public health, a reversible reaction in sensitive populations (asthmatics and allergies) begins at a concentration of 2.8 mg / m³, which is 350 times higher than the odor threshold. For more see: https://ru.wikipedia.org/wiki/Hydrogen_sulfide.

Section 5. Hydrogen Sulfide and Hydrocarbon Poisoning 2014-02-04; 3314 Files

Hydrogen sulfide poisoning

hydrogen sulfide

Hydrogen sulfide is a strong nerve poison that causes death from respiratory arrest. The odor threshold for hydrogen sulfide is 0.01 mg/m³. A slight but clearly perceptible odor is noted at 2 mg/m³, a significant odor at 4 mg/m³, and at 7 mg/m³ a painful odor.

At 11 mg/m³ the smell disappears, please note that the MPC for pure H₂S is 10 mg/m³. At higher concentrations, the smell is absent due to paralysis of the nerve endings in the nose. It is important to know that when a person stays in an environment contaminated with hydrogen sulfide for a long time, one gets used to its smell, therefore poisoning can occur without a feeling of the presence of hydrogen sulfide. The action of hydrogen sulfide is neuro-paralytic, those nerves to which the gas "got" are paralyzed, closer to the respiratory tract: i.e., peripheral nervous system, not central. A further increase in the concentration of hydrogen sulfide cannot be felt by a person up to about 220 mg/m³. Since hydrogen sulfide, absorbed in the nose, simply does not penetrate the entire larynx, but its metallic taste may appear in the mouth. Because hydrogen sulfide is called the "insidious" gas.

The presence of a higher concentration can be guessed by signs of mild poisoning. At a concentration of 200-280 mg / m³, there is a burning sensation in the eyes, photophobia, lacrimation, irritation in the nose and throat - this is when hydrogen sulfide penetrated the throat and formed acid. When a metallic taste appears in the mouth, fatigue, headaches, nausea - this means: the gas has

entered the stomach. When hydrogen sulfide penetrates the lungs and spreads through the blood throughout the body, signs appear: tightness in the chest, lack of air, it is difficult to breathe (the muscles of the ribs are paralyzed), it is difficult to walk to keep balance (loss of coordination, penetration to the muscles of the limbs), it is difficult to speak letters are lost, double vision (the muscles of the lens are affected). Further, the muscle of the heart is affected, and if it is weak, it will stop, if it withstands, breathing will stop. At a hydrogen sulfide concentration of 1000 mg / m³ and above, almost instantaneous poisoning can occur.

- Assess the state of the pupils, respiration, and pulse. By the pupils, we determine when the heart stopped - after 5 minutes, from a lack of oxygen, the eye muscles relax and do not work. By the pulse we determine whether the heart is working, we feel the pulse on the carotid artery, it may not be on the wrist, because it is easier for the heart to pump blood in a small circle - through the lungs and brain, than in a large circle - through the limbs.
- In all cases of poisoning, inhalation of a solution of chlorine is recommended (a handkerchief is wetted in a solution of bleach). Unlike poisoning by associated gases, everything else is the same, ammonia is better there, since ammonia is also an acid, like hydrogen sulfide, a secondary burn will result.
- For mild poisoning (irritation of the upper respiratory tract), warm milk with soda is recommended. In case of loss of consciousness - it is urgent to bring the victim to his senses - by inhaling a chlorine solution, you can sprinkle with water, rub your ears, shake, beat on the cheeks. This is because it is important to do that while a person is conscious, he can force himself to breathe, as he feels a lack of oxygen.
- Severe conditions in case of poisoning can be: loss of consciousness, loss of breath and loss of heartbeat. Naturally, help is different. In the absence of breathing, do artificial, in the absence of a heartbeat - indirect massage. Link to website 868 740.

Section 6. Hydrogen Sulfide Poisoning, Including when Mixed with C1-5 Hydrocarbons

Link 2014-02-04; 3314 files.

Hydrogen sulfide is a colorless gas, heavier than air, with a characteristic odor of rotten eggs.

Gas density 1.54 kg/m³, relative to air 1.19 (air density 1.29 kg/m³ at 0°C). Dissolves in water. In aqueous solution, it is a weak acid. Therefore, it stings the eyes and itches in the throat, which causes a cough. Hydrogen sulfide is flammable. Burns with a bluish flame. Self-ignition temperature -250°C. At a certain concentration of hydrogen sulfide in the air, an explosive mixture is formed. Explosive

limits of hydrogen sulfide in a mixture with air: lower – The action of hydrogen sulfide is neuro-paralytic, those nerves to which the gas has reached, closer to the respiratory tract, are paralyzed. That is, hydrogen sulfide affects the peripheral rather than the central nervous system.

A person simply cannot feel a further increase in the concentration of hydrogen sulfide up to about 220 mg / m³ - since hydrogen sulfide simply does not penetrate the entire larynx, being absorbed in the nose. But at the same time, however, there may still be a metallic taste in the mouth, which is why hydrogen sulfide is called the “insidious” gas. The presence of a higher concentration of hydrogen sulfide can be guessed from signs of mild poisoning. At a concentration of 200-280 mg / m³, there is a burning sensation in the eyes, photophobia, lacrimation, irritation in the nose and throat - this is when hydrogen sulfide penetrated the throat and formed acid. Metallic taste in the mouth, fatigue, headaches, nausea - when it enters the stomach. Chest tightness, lack of air, difficulty breathing (rib muscles paralyzed), difficulty walking, balance (loss of coordination, penetration to the muscles of the limbs), difficulty speaking - letters are lost, double vision (the lens muscles are affected) - these signs appear when Hydrogen sulfide will penetrate the lungs and spread through the blood throughout the body. Then the heart muscle is affected, and if it is weak, it will stop, but if it withstands, then breathing will stop. At a concentration of 1000 mg / m³ and above, almost instantaneous poisoning, convulsions and loss of consciousness can occur, accompanied by rapid death from respiratory arrest, and sometimes from heart paralysis. Maximum allowable concentration (MAC) in the air of the working area: hydrogen sulfide in the air of the working area 10mg/m³; in a mixture

with hydrocarbons (C1 - C5) - 3 mg / m³. MPC for hydrogen sulfide in the air of populated areas - 0.008 mg/m³.

First Aid

1. Put on a gas mask on yourself and on the victim.
2. Take it out of the gassed area to the leeward side, preferably perpendicular to the wind. This must be approached wisely: if the victim should be taken out of the well or from the GZU, then there is no need to
3. For mild poisoning (irritation of the upper respiratory tract), warm milk with soda is recommended. In case of loss of consciousness - bring to life by inhaling a chlorine solution, you can sprinkle with water, rub your ears, shake, beat on the cheeks. It is important to understand why it is necessary to bring the victim to his senses: after all, there is breathing, the heart is working, maybe he himself will lie down and wake up? It is important because breathing can stop after all, when a person is conscious, he forces himself to breathe, because he feels a lack of oxygen.
4. There can be three serious conditions in case of poisoning: loss of consciousness, loss of breath and loss of heartbeat. Naturally, the help is different.: in the absence of breathing, artificial respiration, in the absence of a heartbeat, an indirect heart massage. Link 868 740.

The material was prepared by employees of the Department of Occupational Medicine of the Research Institute of Complex Problems of Hygiene of the FBSI “FNTSG named after F.F. Erisman” of Rospotrebnadzor: MD, prof. Lutsenko L.A., MD Egorova A.M.

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