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NEUTRALISATION OF ASBESTOS-CONTAINING WASTE

Abstract. *The paper presents the characteristics of asbestos as a mineral. Asbestos is a trade name for six serpentine fibrous minerals and amphiboles. The processes of removing asbestos-containing products, which poses a high risk of emission of asbestos fibers harmful to human health, is described.*

First, make an inventory of asbestos-containing waste to determine the sequence of actions. Products can be qualified for immediate disposal or for temporary preservation, as required by law. When removing asbestos-containing products, the contractor should set up warning boards, fence the area, and take technical measures to eliminate the emission of asbestos fibers. Asbestos-containing products must be moistened with water before being removed. Trained employees should be equipped with personal protective equipment as well as working clothes and footwear.

Asbestos-containing waste should be taken to a hazardous waste landfill or an inert or other than inert waste landfill, and placed in areas specially adapted for this purpose.

Precautions during inventory and liquidation of asbestos-containing waste are specified. An innovative technology for asbestos neutralization MTT (Microwave Thermal Treatment) is characterized. The impact of asbestos products on health is discussed. The most dangerous cases of diseases are asbestosis, pleural and pericardial diseases, as well as lung cancer and mesothelioma.

The need for research on the concentration of respirable asbestos fibers in the atmospheric air is emphasized.

Key words: *asbestos-containing waste, environmental pollution, asbestos waste management, impact on human health.*

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ЗНЕШКОДЖЕННЯ АЗБЕСТОВМІСНИХ ВІДХОДІВ

Анотація. *У роботі представлено характеристики азбесту як мінералу. Азбест – це торгова назва шести змієвидних волокнистих мінералів і амфіболів. Описано процеси видалення азбестовмісної продукції, що створює високий ризик викиду азбестових волокон, шкідливих для здоров'я людини.*

Спочатку проводять інвентаризацію азбестовмісних відходів, щоб визначити послідовність дій. Продукція може бути кваліфікована для негайної утилізації або для тимчасового зберігання, як того вимагає законодавство. У разі вивезення азбестовмісної продукції підрядник має встановити попереджувальні щити, огородити територію, вжити технічних заходів щодо усунення викидів азбестових волокон. Азбестовмісні вироби перед видаленням необхідно змочити водою. Підготовлені працівники повинні бути забезпечені засобами індивідуального захисту, а також спецодягом і взуттям.

Азбестовмісні відходи повинні бути вивезені на полігон небезпечних відходів або полігон інертних або інших, ніж інертні відходи, і розміщені у спеціально пристосованих для цієї мети місцях.

Уточнюються запобіжні заходи під час інвентаризації та ліквідації азбестовмісних відходів. Охарактеризована інноваційна технологія нейтралізації азбесту МТТ (мікрохвильова термічна обробка). Обговорюється вплив азбестових виробів на здоров'я. Найнебезпечнішими випадками захворювань є азбестоз, захворювання плеври і перикарда, а також рак легенів і мезотеліома.

Наголошується на необхідності дослідження концентрації вдихуваних азбестових волокон в атмосферному повітрі.

Ключові слова: *азбестовмісні відходи, забруднення навколишнього середовища, поводження з азбестовими відходами, вплив на здоров'я людей.*

Introduction

The name "asbestos" comes from the Greek word asbestion – indestructible, which describes its unique physicochemical properties. Asbestos is a trade name for six serpentine fibrous minerals (chrysotile) and amphiboles (amosite, actinolite, anthophyllite, crocidolite and tremolite). It defines a group of naturally occurring fibrous silicate minerals containing oxides of magnesium, calcium, sodium and iron [1].

Asbestos in the form of fibers is a dangerous environmental pollution, in which, due to its properties, it is practically indestructible. All these features of asbestos and the introduction of asbestos products in mass quantities make it possible to notice the scale of the threat. All elements of the environment, especially the air, are exposed to contamination. Contamination also applies to water and soil, from which fibers can be re-emitted into the atmosphere [2].

Asbestos contamination of the environment can result from natural processes. Natural sources cause greater emissions in terms of the amount of fibers, but it is anthropogenic factors that pose a greater threat. They mostly occur in densely populated areas where the areas of extraction, processing, use and storage of asbestos and asbestos-containing waste are accumulated.

Asbestos exposure can be eliminated through laws and regulations [3]. Currently, more and more attention is paid to the environmental exposure related to the presence of asbestos fibers in the immediate vicinity of humans due to the large accumulation of products containing this mineral.

Although this type of contact with asbestos involves a small amount of airborne fibers, it occurs continuously for many years and may cause an accumulation of the dose. The lifetime of the residual asbestos products guaranteed by the manufacturer has passed, which results in their deteriorating technical condition, leading to increased emission of fibers to the environment.

Asbestos-containing waste disposal

The process of removing asbestos-containing products poses the greatest threat to human health by the emission of harmful asbestos fibers. Asbestos removal work must be carried out in such a way as to eliminate or minimize the release of asbestos into the environment. During works aimed at repairing or removing asbestos-containing products, the contractor is obliged to place warning boards about the type of work being carried out, fence the work site and apply appropriate technical measures to reduce the emission of asbestos fibers [4].

The liquidation of asbestos-containing waste is preceded by an inventory, which determines the degree of urgency, deciding on the choice of the sequence of actions [5]. Products can be qualified for immediate removal or for protection in accordance with the regulations (preservation, painting with acrylic paints). The precautions are as follows:

– asbestos-containing products must be moistened with water before being removed and kept moist throughout the working time;

– plates, fittings and pipes should be completely disassembled, avoiding mechanical damage as far as possible;

– hand tools or low-speed mechanical tools equipped with local dust extractors should be used for work;

– to clean the workplace and equipment, use vacuum cleaners equipped with HEPA filters with 99.95% respirable dust collection efficiency;

– workers should be equipped with personal protective equipment as well as working clothes and footwear;

– removed asbestos products should be packed in polyethylene foil with a thickness of not less than 0.2 mm (the use of paper bags is unacceptable);

– asbestos dust, products and waste of soft asbestos products must be solidified with cement or synthetic resins before packing;

– asbestos-containing waste must be collected and packed in a zone isolated from the surroundings [5; 6].

Disassembly of waste or asbestos-containing products is performed by trained workers equipped with appropriate clothing (masks and protective clothing protecting the respiratory system against the harmful effects of asbestos dust) and technological equipment (Fig. 1).

Asbestos-containing waste should be taken to a hazardous waste landfill. If this is not possible, then, in accordance with the decision of the voivode, they may be placed in specially adapted accommodation facilities at landfills for inert or other than inert waste. In Poland, there are 29 active landfills and plots prepared for the storage of asbestos or asbestos-containing products. The largest of them is located in Dobrów in the Świętokrzyskie Province [5].

Fig. 1. Dismantling of asbestos-cement plates [7]

Currently in Poland there is a legal ban on the production and marketing of asbestos-containing products.

Asbestos fibers neutralization processes

Some European countries use disposal methods other than landfilling. One of them is the technology of asbestos fibers management by dissolving them in 40% hydrofluoric acid. This is followed by a neutralization process with calcium hydroxide to produce calcium fluoride and silica. To increase the effectiveness of this method, the asbestos is crushed into pieces less than 5 mm in diameter. The fraction prepared in this way is conveyed by a belt conveyor to a reactor equipped with a water jacket. After 30 minutes at 65°C (338 K), the acid concentration drops to 10%. The last stage is the neutralization of the formed fluorides and fluorosilicates with a 20% sodium hydroxide suspension. The obtained calcium fluoride serves as a cement filler.

The MTT (Microwave Thermal Treatment) technology is an innovative solution in the disposal of asbestos. It consists in the destruction of asbestos fibers at a temperature of 1100°C (1373 K). Waste neutralization in energy-efficient reactors allows to get rid of hazardous waste, with operating costs many times lower than the so far known and used devices and technologies. The fibers undergo remineralization, and the resulting material is not harmful, because the complete destruction of dangerous fibrous structures takes place [8]. MTT is a safe technology, it does not generate any further hazardous waste, as in the case of the destruction of asbestos using the chemical method with hydrofluoric acids. Moreover, the product produced in the technological process is chemically neutral for the natural environment, constituting a starting product for other technologies.

The effect of asbestos on health

We have known about the harmful effects of asbestos on the respiratory system for over a hundred years. In 1955, the first report of the influence of asbestos on the development of lung cancer in people occupationally exposed to asbestos was published. Subsequent studies confirmed that occupational exposure to asbestos in combination with smoking increases the risk of lung cancer several dozen times in relation to non-exposed people and non-smokers. This resulted in the introduction of legal regulations limiting contact with asbestos: in Great Britain as early as 1931, in the USA in 1979, and in Poland only in 1997 [9].

The first recorded cases of asbestos-related diseases in Poland date back to 1970. There are 200 new cases of asbestos-related occupational diseases annually. According to the International Labor Organization, asbestos can cause diseases such as asbestosis, pleural and pericardial diseases, lung cancer and mesothelioma. The greatest incidence of patients concerns asbestosis [10].

Asbestosis is a disease that slowly causes fibrosis in the lung tissue. Respiratory failure occurs slowly (10 years after exposure). Pleural changes caused by asbestos dust may appear in the form of limited plaques, lumps and exudative reactions. Pleural thickening usually accompanies the processes of fibrosis in the adjacent lung tissue. The clinical course is usually asymptomatic. The latency period is up to 30 years.

Lung cancer occurs 10–40 years from the onset of exposure. The development of cancer is accelerated by asbestosis and smoking. There is sufficient epidemiological evidence to conclude that all types of asbestos increase the risk of lung cancer. The risk of developing lung cancer in the population professionally exposed to asbestos dust varies greatly depending on the type of fiber, processing technology, dust concentration, number of years of work under exposure conditions and the total dose of dust.

Pleural mesothelioma is a rare asbestos-specific malignant neoplasm that develops after 10–40 years from the onset of exposure. Pleural mesothelioma is of considerable interest because of its proven causal relationship with both occupational and environmental exposure to asbestos dust. There is no safe limit for the inspired fiber concentration of fibers that would prevent pleural mesothelioma, however it is believed that a significant risk exists with massive exposures [11].

As you can see, asbestos is very dangerous, but the data cited above refers to occupational exposure [12].

Conclusions

There is an urgent need for a reliable and complete diagnosis of the quantity and condition of asbestos-containing products in individual communes, and then verification of the scale of the asbestos problem in Poland. It will be possible to select areas of special asbestos risk after the completion of a full inventory of asbestos-

containing products and carrying out tests on the concentration of respirable asbestos fibers in the atmospheric air. Due to the insufficient ecological awareness of the inhabitants of the safe use and disposal of asbestos-containing products, it is recommended to conduct an educational and information campaign on these issues. Asbestosis prevention is limited to a small group of people who come into contact with asbestos in their work. They are required to properly protect and use technical measures to prevent dust emission and its introduction into the respiratory tract [13].

Very often, environmental costs are omitted or underestimated, which include the costs of using the environment, including fees and penalties, costs of building asbestos-containing landfills, the value of lost benefits related to the use of land after remediation, because asbestos-containing rehabilitated land cannot be used in economic and recreational purposes.

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