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Development of the recycling industry and its significance

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Abstract

The article points out that the growth of solid waste in the world is a source of danger to the environment. Among the solid wastes, the waste formed from construction materials is widespread, occupying vacant lands and forming large landfills. For this reason, the benefits of recycling – protection of the environment from excess waste, thereby release of useful lands as well as protection of atmosphere from pollution, and less use of natural resources have been emphasized. While using raw materials in the chemical industry, development of harmless and waste-free technologies has been shown as one of the main ways to eliminate environmental problems.

Keywords: solid waste, construction waste, recycling, development, chemicals, waste-free technology

Аннотация

В статье отмечается, что увеличение твердых бытовых отходов в мире является источником опасности для окружающей среды. Показано, что среди твердых отходов широкое распространение получили отходы, образующиеся от строительных материалов, которые занимают пустующие земли и образуют крупные свалки. По этой причине отмечены преимущества вторичной переработки - избавление окружающей среды от лишних отходов, тем самым высвобождая плодородные земли и защищая экологию, а также атмосферу от загрязнения, которые приводят к меньшему использованию природных ресурсов. При использовании сырья в химической промышленности, разработка безвредных и безотходных технологий была представлена как один из основных способов устранения экологических проблем.

Ключевые слова: твердые отходы, строительные мусор, вторичная переработка, разработка, химикаты, безотходная технология

In modern times, the world is constantly evolving. The growth of the world's population and the expansion of cities have led to a further increase in annual production. On the other hand, as the chemical industry developed, the range of industrial products expanded. For this reason, the increase in consumption and, consequently, production has increased the demand for resources. Natural resources in nature are limited over time. In this case, there is a shortage of raw materials required for production, which leads to delays in the process and failure to meet the growing consumer needs [1-3].

While scientific and technological progress is constantly improving human life, it is also creating various environmental problems. As a result of human activities, a large number of harmful substances enter the environment. One of the sources of harmful effects on the environment is the chemical industry. Until now, more than 3 million new types of chemicals not accustomed to nature have been identified. On the other hand, the use of the achievements of chemistry is an important condition for solving environmental problems [3].

One of the main ways to overcome environmental problems is the development of harmless and waste-free technologies in the working out of new types of materials from raw materials [1-3].

Waste-free technology means a system of efficient use of all components of raw materials, types of energy without disturbing the ecological balance of the raw material-production-operation cycle. Waste-free technology can be implemented in workshops, factories, associations, fields and within the region. It is practically impossible to create a completely waste-free technology. In reality, low-waste technologies can be created. The main principles of waste-free technology include integrated processing of raw materials, use of energy sources, closed water and gas circulation, new high-efficiency, environmentally friendly and low-waste processes, reuse of waste, etc. [1].

In order to meet the needs of one person, 20-30 tons of mineral raw materials are extracted from the ground every year, which does not exceed 1-3% of the final product. Due to this, as a whole more than 100 billion tons of industrial waste per year are generated in the planet. These include rocks, ferrous and non-ferrous metal production wastes, slag and combustion products from blast furnaces, thermal power plants and other furnaces, and wastes from the chemical and other industries. As the world population's needs grow year by year, its mineral and ore reserves are constantly declining. Due to useful components, the demand for the use of poor ore deposits is growing. This leads to an increase in the amount of rock that forms waste. Thus, the volume of industrial waste is constantly growing. These wastes, which are formed in large quantities, occupy a significant area of land, enter the atmosphere in the form of dust and the hydrosphere as a solution. Solid waste is considered environmentally hazardous because of its high content of harmful substances. Therefore, the need for industrial waste treatment is important [1, 3].

According to the research, only in the United States in 2012, about 280 million tons of solid industrial waste was formed. Solid industrial waste management, which causes excessive pollution, has always been a major challenge around the world. Burial and incineration of waste as a common method without control has led to problems such as soil, water and air pollution [3].

Vietnam is considered one of the top five countries in terms of solid waste generation, with about 13 million tons per year. It has been estimated that in 2017, Vietnam generated 38,000 tons of household waste per day. Improper handling of such a waste problem can damage the urban environment. The Vietnam Environmental Administration says that the country's household waste production increases by 10-16% annually [5].

Due to the rapid development of industrial waste, mankind is faced with the need to use new technologies for waste disposal. Today, about 94% of waste in Russia remains in special landfills. In Europe, though this figure is very low (40%) it remains undesirable [2]. According to Rostechology, about 40% of the waste collected in Russia is considered valuable - secondary raw material and can be recycled [6]. It has been estimated that about 11.5 million tons of construction waste is annually generated in Moscow, and in the near future the increase in the amount of concrete crumbs during demolition, reconstruction, overhaul and assembly of non-standard structures will reach 13-15 million tons per year [7].

According to a special instruction of the European Union, in 2020, seventy percent of the waste generated during the construction and demolition of buildings will be sent for recycling. In Finland, the future use of this type of waste varies both by classification and region. The wooden materials in a very bad condition are burned because their reuse is difficult. Concrete crumbs from the demolition of buildings are mostly used in earthworks. At

the same time, 250,000 tons of construction waste are still sent to the landfill. In Finland, recycling of construction waste accounts for twenty-six percent of all non-waste energy [8]. According to scientists, the amount of waste is expected to increase to 3.4 billion tons by 2050.

Many industrial wastes have valuable components. Such wastes are considered raw materials for new production areas. For example, ferrous metallurgical wastes contain Ti, Ni, Cu, Au, Pt and other metals. The ashes of coal and burning shales contain Ge, Mo, V, Re, Ag, Au and other elements. Therefore, it is possible to obtain large amounts of valuable substances from the processing of such wastes. Wastes from many other industries can be used to make building materials. Metallurgy (slag), thermal energy (waste), chemicals and other areas can be exemplified to such production areas [4].

Every day, thousands of tons of waste are collected from modern cities and transported to special landfills for burial and incineration. However, the area of such places on the earth is limited. But the amount of incoming waste exceeds their capacity, and that is why, the waste mountains are rising every day. According to experts, up to 75% of this waste can be recycled. Large amounts of unprocessed waste have a serious negative impact on the ecological condition of the planet [9]. That is why, there is a need to establish high-quality waste processing plants.

Municipal waste is sent to pre-defined areas or waste incinerators. Despite the simplicity and efficiency of the work, such use of waste is severely criticized for its damage to the environment. Burial of waste over time causes methane gas to leak into the atmosphere, which is more harmful and dangerous than carbon dioxide in terms of increasing the "greenhouse effect". In addition, buried waste can poison groundwater as it is a source of leakage of harmful substances. Since the process of dissolving many waste materials in nature takes thousands of years, there is a need to constantly expand the areas for their collection or burial. This is a stronger alarm for large cities, as vacant space in such cities is limited and expensive [3]. Incineration, in turn, releases greenhouse gases and harmful chemicals into the atmosphere, which pollute the environment and accelerate global warming.

Making new products from previously used and recycled materials saves energy. As a rule, the processing of ready-made material requires less energy. For example, making paper from waste paper is 40% faster than making it from wood. Energy conservation affects less water and air pollution. In addition, waste recycling significantly reduces the use of raw materials, which leads to savings and conservation of natural resources. Processing of one ton of newsprint protects 12 trees [9].

Construction waste is the waste generated during construction, repair and other works. All construction - demolition, restoration and repair projects, insulation materials, electrical wiring, concrete, construction materials, wood, plaster, scrap metal, cement, glass, asbestos, bricks, various packaging materials generate a large amount of waste. The statistics of the distribution of these wastes are shown in a percentage in Figure 1 [10].

Fig.1. Distribution of construction waste by %.

Every year, construction waste occupies and is buried in an area that is growing, adversely affecting health and damaging the environment. In this regard, there is a need for secondary measures - recycling of construction waste and finding areas for their application [11-12]. Concrete is one of the most widely used artificial building materials in the world. Concrete has many advantages over other building materials, such as abundant resources, easy operation, stable mechanical properties, durability. The production of green concrete meets three requirements: very low energy and resource consumption, low pollution and sustainable development [13]. During production of one ton of cement 0.9 tons of CO₂ releases. 10% of a cubic meter of concrete is cement. Thus, it is possible to reduce CO₂ emissions into the atmosphere using green concrete in environmental construction techniques [14].

Studies have shown that waste limestone and waste silicon dioxide can be a substitute for cement used in the preparation of concrete [15].

Silicon mist and waste glass have been used in the production of cement and concrete. The hardening properties of new concrete obtained using silicon mist and waste glass have been studied in the research [16]. The strength properties of concrete have been improved by the incorporation of silicon mist and waste glass to a certain composition. The workability of concrete decreased with the addition of silicon mist and increased with the inclusion of waste glass [16].

In order to reduce silicon-rich wastes they have been used in the manufacture of mesoporous materials [17]. The synthesis template for porous carbon materials typically requires selective removal of silicon from carbon/silicon composites. The recycling of nano-cast silicates has been successful for the first time in the recovery of meso-porous MCM and SBA-type silicon materials, which will not only save valuable chemicals, but also reduce chemical waste and improve environmental standards [18].

Geopolymer has been produced using aluminum oxide and silicon (IV) oxide wastes as raw materials. The used alumina waste is from the aluminum thermal metallurgy plant in Thailand, and the silicon (IV) oxide waste is obtained from the recycling industry. The obtained geopolymer samples have been analyzed. The study of the concentration of heavy metals has shown that after the formation of the geopolymer, the heavy metal is stabilized in the structure with a lower concentration, and geopolymer products are no longer hazardous waste [2].

The use of low-waste technologies in the chemical industry, as well as the discovery of new applications for waste, thus releasing useful lands and protecting the atmosphere from pollution, are considered to be the achievements of green chemistry.

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