

## MUNICIPAL SOLID WASTE IS ENVIRONMENTAL HAZARD

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**Purpose.** The article describes aspects of the environmental impact of municipal solid waste (MSW). Purpose of the paper is analysis of environmental problems, which are created by MSW, ways of solution and modern state of MSW recycling in developed countries and Ukraine. **Methodology.** We have applied the analysis of the current situation with municipal solid waste management by means of literary sources, statistical data and evaluation of the extent of threats.

**Results.** Annual waste volume growth has set a problem of recycling and reusing for humanity. Traditional methods of disposal of municipal solid waste are storage in landfill and incineration. But waste disposal is environmentally unacceptable. This method forms epidemiological and biological hazards; garbage can catch fire themselves and emit the harmful products of combustion. Simultaneously aquifers are polluted by leachate. Incineration in plants reduces the volume of waste and its danger, but this process forms even more harmful emission. Therefore, such technologies require extremely effective systems of the flue gases cleaning, and they have cost about of 40% of the worth of the enterprise. One of the most promising technologies of MSW recycle is pyrolysis, it allows getting combustible materials, but because of the huge cost of the technology, its using is still very limited.

All modern waste treatment technologies are based on prevention (preparing for) reuse and further recycling. The developed countries have recycled nearly 90% of the waste. In Ukraine, more than 90% of waste is taken out to dumps and landfills. Ukraine needs to improve the system of waste management. **Originality.** We have carried out the integrated analysis of the situation with MSW. We have offered possible solutions to the MSW problem in Ukraine. **Practical value.** We have determined the bulk of municipal solid waste has being taken to landfills. It is the main source of environmental problems across our country. If in the nearest future reliable recycling program will not be created, Ukraine can become an area of environmental disaster. *References 10, figures 1.*

**Key words:** landfill, municipal solid waste (MSW), pyrolysis, recycling, leachate.

## ТВЕРДІ ПОБУТОВІ ВІДХОДИ – ЕКОЛОГІЧНА НЕБЕЗПЕКА

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Розглянуто аспекти впливу на довкілля твердих побутових відходів (ТПВ). Щорічний ріст обсягів утворених відходів та екологічні загрози, які вони створюють, поставили перед людством задачу їхньої переробки і утилізації. Традиційні способи знешкодження ТПВ – це складування на полігоні та спалювання. Але складування є екологічно неприйнятним через епідеміологічну і біологічну небезпеки, здатність злежаного сміття самозайматись, виділяти при цьому шкідливі продукти згорання. При складуванні відбувається і забруднення водоносних горизонтів через формування фільтрату. Спалювання на сміттеспалювальних заводах значно зменшує обсяг і небезпечність відходів, та при цьому створюються умови для ще потужнішої емісії шкідливих викидів. Тому подібні технології потребують високоякісних і потужних систем очищення димових газів, вартість яких складає до 40% від вартості самого підприємства. Однією з найбільш перспективних технологій переробки ТПВ вважається піроліз, який дає змогу переробити непотрібні рештки на горючі матеріали, але через величезну вартість технології її використання поки що дуже обмежене.

Всі сучасні технології переробки ТПВ базуються на попередньому сортуванні сміття та подальшій утилізації ТПВ. У розвинених країнах таким чином переробляється до 90% відходів. В Україні ж більше 90% відходів продовжують звозити на звалища і полігони. Тому наша країна потребує термінового удосконалення системи поводження з ТПВ.

**Ключові слова:** полігон, тверді побутові відходи, піроліз, утилізація, фільтрат.

**PROBLEM STATEMENT.** Technical progress and rapid economic development have been the main causes that led to the irresponsible attitude towards nature.

The result of this is a serious environmental deterioration on the planet. These are a climate change, ozone depletion, and acid rain, harmful concentrations of radioactive isotopes, reducing soil fertility, soil erosion and chemicals pollution of soil, water, and food and so on. Urbanization has generated another big problem in cities around the world. This is the accumulation of large amounts of municipal solid waste (MSW).

This waste is the inevitable result of urban life and its eternal companion. Currently, they have become serious environmental pollutants. However, as the practice of developed countries has showed, intelligent utilization of waste can provide a significant positive economic impact.

Urban landfills even of a midsize city annually collect hundreds of thousands of tons of MSW. During decomposition they poison the air, soil, and groundwater and become thus a serious danger to the environment and humans. In this context, searching and using of efficient, waste-free, and the most importantly, environmentally friendly technologies for industrial recycle of waste are becoming quite a topical task.

Purpose of the paper is analysis of environmental problems, which are created by MSW, ways of solution and modern state of MSW recycling in developed countries and Ukraine.

**EXPERIMENTAL PART AND RESULTS OBTAINED.** Each year more than half a trillion tons of solid waste are formed on our planet [1]. In addition, the amount of MSW increases each year. It are established that increasing population on the Earth by 1.5 – 2% increases the amount of MSW by 6% [2]. However, not only population growth causes an augmentation of MSW. It is more associated with changing lifestyles and increasing the living standards of the urban population. For example, we know that over the past 2 decades, the population of Ukraine has decreased by 10%. However, the amount of household rubbish has increased by 40% in the same period [3]. That is, there is an annual increase of MSW amount by 1.78 %. Under these conditions, this number will be doubled every 40 years.

At the current pace of growth of the MSW quantity over the next century, all the major cities of the planet would be swamped with waste, and poisoning the air, surface water by the products of their decomposition, would make them unsuitable for life.

The most common way to deal with garbage in cities is disposal and burial at the landfills (in many countries this method are basic). This method does not solve the problem but only complicates it. The dumps are not only epidemiological danger. They are inevitably becoming a powerful source of biological contamination. Clearly the overall picture of environmental threats of MSW which are stored in dumps is represented by M. Krasnyansky [4].

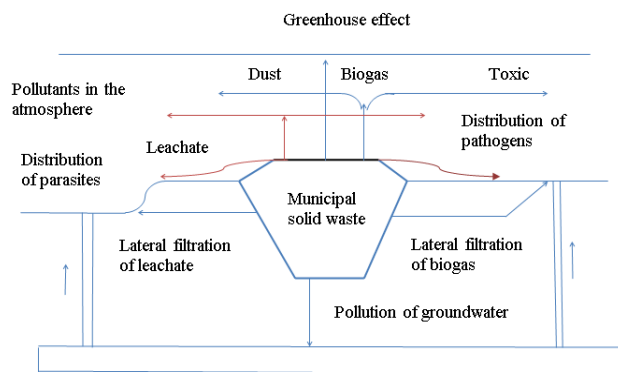


Figure – Environmental hazard of dumps [4]

A landfill is a kind of "biochemical reactor", because in its thickness significant amounts of toxic gases ("landfill gas") and the liquid leachate are formed, fly larvae are born, the harmful microorganisms (dysentery, hepatitis, tuberculosis and even typhus) develop; MSW landfills attract rodents and birds. Landfills (especially spontaneous) can ignite themselves, forming combustion products: carbon dioxide, oxides of nitrogen and methane, which are powerful greenhouse gases. "Landfill gas" contains hydrogen (1%), hydrogen sulfide (0.5 – 1.5%), ammonia (0.5%), and even traces of highly toxic chlorinated hydrocarbons, dioxins and furans [4].

Contamination of water horizons near MSW landfills is associated with formation of so-called "leachate". It is a gray-black liquid that flows constantly from the thickness of waste. Its composition is characterized by a high level of oxidation, the presence of heavy metals and high concentrations of chlorides and sulfates [5, 9].

Hence, disposal of MSW in landfills should be seen as a forced, short-term solution, which is contrary to environmental aspects.

Currently, there are projects relatively environmentally save solid waste landfills [4]. These landfills are complex technical facilities. In accordance with international standards, they are, in addition multilayer insulating bottom from opaque film should include drainage system devices to collect and biogas and leachate, and special equipment for cleaning and disinfection of the leachate. These landfills require significant cost for their construction and maintenance. Therefore, in countries with weak economies the main method remains waste disposal to landfill.

Another way to deal with the growing problem of MSW accumulation is a simple incineration. However, the products of MSW combustion can contaminate the environment.

Many years of work of incineration plants in Rotterdam (Netherlands) had resulted in cow's milk contamination by dioxins in a radius of 30 miles so that this foodstuff was prohibited to sell. In Sweden, waste incineration plants had emitted 0.5 tons of cadmium, 3.3 tons of mercury and 8,400 tons of hydrochloric acid. A

slag and ash of the incineration plant contains high concentrations of heavy metals [1].

Next way is sorting and recycling of MSW, because they are a valuable raw material. Each country solves the problem of waste management in own way. Developed countries try to recycle most of the waste and to take out less to landfills. Residents themselves have sorted garbage before removing. Almost all European countries have strict rules about rubbish sorting for recycling. In Germany and Sweden, people themselves have pre-sorted over 80% of waste. Denmark, Belgium, Switzerland, the Netherlands, Austria, France, Italy, the USA and Japan not only sort waste, but use solid waste as secondary raw materials else. In most countries, the degree of domestic waste treatment exceeds 50% [3]. Economic incentives for sorting and fines for non-compliance have promoted success in Europe. At the same time in Ukraine only about 5% of solid waste are used as secondary resources. In Switzerland, MSW is sorted by residents in 15 types of components. In Ukraine, only three types of waste are recycled partially: PET – bottles, glass and paper [3].

The thermal method (incineration) is the most effective way to deal with waste. It makes it possible to reduce the amount of waste is stored, in ten times [3]. Plus, unburned remains do not contain organic substances that cause spontaneous combustion and decay, so the epidemic probability is reduced to zero. But incineration has its drawbacks. The main danger is hazardous emissions of dioxins and furans due to the increase in the proportion of plastic waste. The risk associated with the release of these substances is determined by their specific physical and chemical properties. Going into the soil and water, dioxins form complexes with organic matter and are actively disseminated in the environment. They easily stick to dust particles and are transported by air, water and soil. In the human body, chlorinated hydrocarbons suppress the immune system, unbalance irreversible metabolism, and disrupt human hereditary apparatus.

Quantity of dioxins and furans formed during combustion depend on the temperature (their decomposition is effective in temperatures above 1250<sup>0</sup>C and exposure more than 2 sec.). Secondary formation of these substances may be during a slow cooling of flue gases in the temperature range 200 – 450<sup>0</sup>C [4]. Because spontaneous combustion of MSW dumps is a great danger.

In the United States a modernization program of incineration plants has started. Its mission is minimizing of unwanted emissions. In Japan, more effective methods of incineration have been developed, such as combustion in fluidized bed furnaces, combustion layered, low temperature gasification.

Today, life of major cities is impossible without plants for burning of household waste. Waste incineration plants solve several problems. Firstly, they recycle and destroy a large number of garbage that a

modern city forms every day. Secondly, the heat from the burning is used for steam production, which heats homes, plants and farms. And, thirdly, an advantage of incineration is that simultaneously with heat output, it reduces an amount of residues that are taken to landfills 10 times or more.

Maximum of incineration plants building had been during the energy crisis of the 1970s. In developed countries, hundreds incineration plants were built. It seemed solid waste disposal issue is solved. But that time waste incineration plants had no reliable equipment for cleaning exhaust gases.

Since the second half of the 1990 construction of second generation of incineration plants has been begun in Europe. About 40% of cost of these plants is cost of modern efficient smokes treatment. But the essence of MSW incineration processes is virtually unchanged. Now there are more than a dozen combustion technologies for municipal waste in a world practice.

Currently, thermal destruction of MSW prevails in most developed countries. In Japan, 82% of garbage is burned, in the US - 81%, as of Denmark - 78%.

However, despite all positive features of new technologies, incineration is connected with the release of toxic substances into the atmosphere.

In addition to carbon dioxide, heavy metals, mercury, chlorinated derivatives, toxic chlorophenols, slag and more are emitted in the atmosphere. These pollutants are deposited on the ground and absorbed by plants, including fruits and vegetables. They get into the oceans and drinking water. Thus, today role of the incineration plants is reviewed; mankind is looking for other ways to get rid of garbage.

Secure disposal of ash, slag and flue gas is provided by combined technologies incineration at high temperature. These include, for example, considerably safer complex technology from German company "Siemens», which is called "Pyrolysis - high temperature incineration." Pyrolysis is a thermal decomposition of organic matter almost without oxygen.

The first large-scale plant working on this technology was built in Vyurte (Germany). The new method combines low-temperature pyrolysis and their subsequent combustion at high temperature.

Combined technology of company "Siemens" sets itself apart from others in that, firstly, fuel resources are received from waste materials, that suitable for using with little or no further treatment. Second, cleaned flue gases correspond to high environmental standards.

Situation with MSW is becoming more and more difficult in Ukraine. Now the bulk of garbage (90 – 95%) is taken to dumps, to 10% of waste is burned. Dumps have turned into a ticking bomb, causing huge damage to the environment, and hence people. The results of such a situation with MSW are the spread of infectious diseases, pollution of surface and groundwater, high content of toxic substances in the air near dumps.

Unclear situation has developed with recycling of extremely hazard waste in Ukraine. We know one battery can contaminate about 400 liters of water or 20 m<sup>2</sup> ground due to the presence of heavy metals in one [3]. In developed countries, including the EU, the old batteries are recycled by special waste disposal service. In Ukraine battery collection places are rarity.

An issue of disposal of waste oils (from transmission, engine, hydraulic, industrial, and so on) also remains. This substances cause irreparable damage to the environment. Thus, only 1 liter of engine oil spilled into the soil can contaminate 100 – 1000 tons of groundwater [3]. Most Ukrainian pours waste oil into the water or leaves in dumps. However, they can be used as a fuel. Automobile waste oil should be burned, but only with special treatments using.

In recent years, the legislative and executive authorities of Ukraine have taken a range of concrete actions to minimize the negative effects of waste treatment. There are two processing methods actually: an incineration or a disposal at dumps (landfills). Each of them has its drawbacks, especially regarding the harmful effects on the environment. Especially it concern to the second method, because the existing waste incineration plants converted only about 1% of the total MSW in our country. The bulk of waste, 60% of which is made by residents has being taken to landfills. It is the main source of environmental disasters across our country. According to changes to the law "On Waste" introduced in 2010 by the Parliament in Ukraine, incineration plants are banned for using, if its technology does not involve concomitant production of heat and electricity. In addition, unprocessed MSW has been allowed to take to landfills only to 2018.

The Cabinet of Ministers has developed and approved a national program "Clean City" with a budget of nearly 5 billion UAH, implementation of which was entrusted to the State Agency for National Projects [8]. The "Clean City" is based on the thesis: waste is a valuable source of almost inexhaustible resources that can and should be recycled, by using available worldwide advanced technologies.

This project has involved the construction of modern facilities for processing of pre-sorted municipal waste in 10 large cities.

However, drafted projects of existing waste incineration plants modernization aimed to generate heat and electricity remain on paper due to the difficult situation in the country. Recycling of rubbish in cities and towns is an important and necessary social challenge. Its solution determines the welfare of all citizens and the epidemiological situation.

CONCLUSIONS. Constant tendency of MSW amount grow and its environmental damages makes to

improve waste recycling and finds ways of safe treatment.

The cost of capital investments associated with the processing of MSW eventually will pay off, because their utilization gives not only environmental but utilitarian effect.

Modern environmental situation in Ukraine is connects with consequences of extremely complicated economic state of country. But at the same time, if in the nearest future reliable recycling program will not be created, and then soon Ukraine can become an area of environmental disaster.

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## ТВЕРДЫЕ БЫТОВЫЕ ОТХОДЫ – ЭКОЛОГИЧЕСКАЯ ОПАСНОСТЬ

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Статья посвящена аспектам воздействия на среду твердых бытовых отходов (ТБО). Ежегодный рост объемов ТБО поставил перед человечеством задачу их переработки и утилизации. Традиционные способы обезвреживания ТБО – это складирование на полигоне и сжигание. Но захоронение отходов является экологически неприемлемым из-за эпидемиологической и биологической опасности, способности слежавшихся отходов к самовозгоранию и выделению при этом вредных продуктов горения. При складировании происходит и загрязнение водоносных горизонтов вследствие образования фильтрата. Сжигание на мусоросжигательных заводах значительно уменьшает объем и опасность отходов, но формирующиеся при этом дымовые газы отличаются еще большей токсичностью. Поэтому подобные технологии требуют очень мощных систем очистки дымовых газов, стоимость которых составляет около 40% стоимости всего предприятия. Одной из наиболее перспективных технологий переработки ТБО является пиролиз. Он дает возможность переработать ненужные остатки в горючие материалы, но из-за высокой стоимости технологии ее использование пока очень ограничено.

Все современные технологии переработки ТБО базируются на предварительном сортировании мусора с последующей утилизацией. В развитых странах так перерабатывается до 90% отходов. В Украине же более 90% отходов продолжают свозить на свалки и полигоны. Поэтому наша страна нуждается в немедленном усовершенствовании системы обращения с ТБО.

**Ключевые слова:** полигон, твердые бытовые отходы, пиролиз, утилизация, фильтрат.