

## ENVIRONMENTAL PROBLEMS OF INCINERATION PLANTS

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**Purpose.** The article determines of acceptable for Ukraine municipal solid waste recycling, based on the analysis of existing techniques using of incineration plants. **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.** The rapid development of industry and urbanization has led to a significant increasing in solid waste, which causes serious environmental problems near large cities. The most prevailing modern method of the solid waste processing is incineration. Gradually development of waste incineration techniques has done the most effective ways as following: an incineration with a fluid bed in the furnace, layer burning, low-temperature gasification. These techniques have to be accompanied by powerful gas treatment. Polymer component of MSW has been forming additional difficulties in the last decade. They might form extremely toxic substance during combustion. Analysis of global waste recycling experience indicates that for developing countries with poor economy the most appropriate waste treatment is sorting and recycling waste that can be recycled and incineration at waste incineration plants that cannot be recycled. **Originality.** We have carried out the integrated analysis of the MSW incineration ways. An acceptable resolution of municipal solid waste recycling for Ukraine has been offered in the article. **Practical value.** We have determined the most appropriate ways for waste recycling in Ukraine. It can be basis for choice of processing line and design of a waste incineration plant in Kharkiv. If in the nearest future reliable recycling program is not be created, Ukraine will not be able to become an area of environmental disaster. *References 9, figures 0.*

**Key words:** environmental science, municipal solid waste (MSW), incineration plant (IP), sorting, recycling.

## ЕКОЛОГІЧНІ ПРОБЛЕМИ СМІТТЄСПАЛЮВАЛЬНИХ ЗАВОДІВ

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Стаття присвячена проблематиці вибору екологічно безпечного і економічно доцільного напрямку поводження з твердими побутовими відходами в Україні.

Екологічні проблеми, які склалися в нашій державі завдяки обсягам накопичених твердих побутових відходів та їх невпинному зростанню, набувають загрозливого характеру і вимагають термінового вирішення. Поступовий розвиток технологій переробки сміття на спеціальних заводах полягає у використанні високотемпературного спалювання, в тому числі в печах киплячого шару, пошарового спалювання, низькотемпературної газифікації, що супроводжується потужним комплексом газоочисного обладнання. Значною проблемою є збільшення частки полімерних відходів, які при спалюванні можуть спричинити утворення надтоксичних сполук. Аналіз світового досвіду переробки відходів свідчить, що для держав зі слабкою економікою найбільш доцільним буде використання сміттепереробних комплексів із сортуванням і утилізацією частки відходів, що є вторинною сировиною, та спалювання на сміттєспалювальних заводах тієї частки, яка не підлягає утилізації.

**Ключові слова:** екологія, тверді побутові відходи, сміттєспалювальний завод, сортування, утилізація.

**PROBLEM STATEMENT.** Municipal solid waste (MSW) is a permanent component of human activity, but over a long historical time it has not been a threat.

The rapid development of industry and urbanization caused a significant increase in solid waste, which has resulted in serious environmental problems near large cities.

These problems are threatening in Ukraine too. The objective reasons for this are the significant growth of the solid waste amount, an appreciable change of its composition owing to increasing the most dangerous plastic components, economic failure in applying of modern technologies for MSW processing. The aggravation of this problem connects with following

reasons: lack of systematic approach in the urban development projects, which should include objects of waste recycling; non-fulfillment of legislation and relevant decisions of the MSW problem; low awareness of urban residents about attitude to the MSW.

*Relevance of the paper.* The most prevailing modern method of the solid waste processing is incineration. However, despite the great variety of combustion technologies, all incineration plants (IPs) have a significant drawback. It is harmful emission into the atmosphere. The most advanced incineration technologies are too expensive for most countries. Huge amount of waste requires studies of environmental friendly ways for waste recycling based on incineration plants using. It is very important, that these techniques must be available for developing countries with poor living standard like Ukraine.

*Purpose of the paper* is determination of acceptable for Ukraine MSW recycling ways, based on the analysis of existing techniques with using of incineration plants.

**EXPERIMENTAL PART AND RESULTS OBTAINED.** MSW processing is improved constantly. Disposal of MSW at dumps and landfills has prevailed in the early stages (poor countries are using this technique as main way now) but we should consider it as a forced, temporary way.

This way does not solve the problem but only complicates it. The dumps are source of epidemiological danger and biological contamination [1, 2]. The relatively environmentally friendly landfills are complex technical facilities which require of significant outlays for their construction, technical equipment and maintenance [2].

Burning of municipal solid waste at the incineration plants has become a major and the most progressive way of their processing. From 1960s many European countries have been building equipment for waste incineration. After creation the first IP in England in the late of 19th century, Europe started their massive construction. The boom occurred in the second half of the twentieth century. Hundreds of first generation IPs with simple burning of solid waste and heat recovery were built. It seemed, the problem was solved, but environmentalists concluded that these plants are powerful sources of harmful emission into the atmosphere. This emission contains more than 75 dangerous substances, for example more than 20 kinds of dioxins, mercury, lead and other heavy metals. So quite simple and relatively cheap the first generation IPs had to be closed or the gas emission treatment had to be significantly improved.

Since the second half of the 1990s construction of second generation of IPs has been begun in Europe. Worth of effective smoke treatment is equal to about 40% from cost of an all plant.

More than a dozen solid waste incineration techniques are used now. Thermal high-temperature combustion is the most effective way. It has become

really efficient way because it reduces waste amount in 10 times. In addition incineration residues do not include organic matter which might cause spontaneous combustion and decay; these residues do not pose an epidemiological threat and are safe for disposal at the landfills.

Currently, most of developed countries prefer thermal MSW destruction. In Japan, 82% of MSW is burned and 14% waste is transported to landfills. For the US this correlation is following: 81% to 12%, in Denmark 90% and 9% respectively. In Ukraine no more than 5% of solid waste is burned and 95% is taken to landfills in unprocessed form.

Considering the advantages of thermal destruction for solid waste, scientists worked out the ways to reduce the harmful environmental impact of burning. In the US, a modernization program of the IPs to minimize unwanted emissions has been started. In Japan an efficient incineration with a fluid bed in the furnace, layer burning, low-temperature gasification was developed.

Burning on a grate layer in the furnace was the most common, but not the most perfect way. Waste burning in the furnaces with fluidized bed is used in Japan. In the US an incineration plant burns waste in a circulating fluidized bed. But these both techniques do not provide a complete solution for the problem of solid residues - slag and ash is captured by gas cleaning systems not completely. The slag can be used in construction, the ash absorbing heavy metals and other toxic substances requires disposal at special equipped landfills.

So, second generation IPs providing a significant harmful substances emission reduction did not solve the emission problem completely. During recent decades the searching and development of more environmentally friendly combustion has not been stopped, that resulted in the development of third generation IPs. These plants carry out single-stage or two-stage combustion, virtually no waste, for both sorted and unsorted garbage. Neutralization of main amount of harmful and toxic substances has been provided by burning under special conditions in the furnace or by absorption into solid, monolithic (harmless for later using) slag.

Effective gas emission treatment, decontamination of ash and slag is provided by two-stage combustion. The technique "Pyrolysis - high-temperature incineration" worked out by the German company "Siemens" combines low-temperature pyrolysis (treatment of waste without oxygen) and its subsequent burning under high temperature condition [3]. This technology is almost without waste. Almost all waste materials can be recycled; gas purification used meets the most stringent requirements; a significant amount of heat produced can be used both to generate of electricity and to heat. Expensive cost is a drawback of this way.

A draft of a multi-continuous melting unit "Magma" was worked out in Russia, (Chelyabinsk) [4]. The non-waste incineration for unsorted MSW under high temperature condition is carried out in the presence of

oxygen on the surface of slag solution superheated to 1500 ... 1690° C. The slag solution forms from the mineral component of the waste. The temperature of a gas phase in this unit reaches 1800 ... 1900 ° C. The obtained slag is discharged from the furnace time to time. It is solid and compact; it does not emit any harmful substances and can be used for production of building materials. Having taken by gas cleaning unit, ash is returned into a melting chamber to the slag solution by specific ejectors and is fully assimilated by the slag. The amount of harmful emissions from incineration unit "Magma" completely meets the EU environmental standards.

Polymer component of MSW has been forming additional difficulties during the last decade [5]. Burning of polymer materials containing chlorine (amount of this polymers is about 50%) inevitably causes creating of chlorine-containing toxic substances in flue gases - dioxins and furans. The total number of these components is about 20 kinds of different hazard classes. The danger associating with these substances is determined by their specific physical and chemical properties. Going into the soil and water, dioxins form toxic complexes with organic substances and spread in the nature. The chlorinated hydrocarbons can accumulate in human bodies, suppress the immune system, unbalance the metabolism irreversible, and disrupt human hereditary apparatus [1].

It should be noted that the high-temperature combustion in the IPs (more than 1000 °C), forms dioxins and furans in ten times less than the low-temperature combustion of solid waste (less than 600° C), which may occur during spontaneous combustion in landfills. The incineration plants help control and reduce harmful emissions as well as to manage this process.

Many countries are using MSW recycling with previous sorting. More than 50% of solid waste components are recycled in this way as secondary raw materials and it reduces load for IPs [3].

If urban residents are sorting waste themselves (for example, in Sweden about 14 kinds of MSW components are sorted by people) there is no need for sorting lines. Otherwise we need to create waste processing facilities which include a sorting line, an IP, and a landfill for residue small amount dumping after burning. At the advanced plants, residues which are not recycled are less than 1%.

Obviously the waste treatment facilities with MSW incineration using modern technologies and full implementation of environmental requirements are prioritizing way of municipal solid waste management.

Dump disposal of MSW is the major way of waste utilization in Ukraine. There are four built incineration plants in Ukraine and the only IP is working in Kiev. Ukraine has got an acceptable legislation about MSW and some authority activity for environmental safety [6, 7, 8], but there are no real progress steps.

A resolution №265 of the Ukraine Ministers Cabinet approved the "Program of household waste for the period until 2011." As a result of its implementation, modern processing facilities were to create. But it did not occur.

A law establishing a mandatory separate waste collection came into force in 2010. Now 3...4 types of MSW are selected: PET bottles, waste paper, oversized waste, but this is not enough.

The legislation of Ukraine establishes that conditions for separate collection of household waste should be created by means of implementing of social and economic mechanisms to stimulate this way. But these conditions have not been developed and implemented. The mentality of Ukrainian people requires educational hard work in this area.

Developed and approved in 2013 a national program "Clean City" with a budget of about 5 billion UAH provided construction of advanced systems for MSW recycling in 10 Ukrainian cities by the end of 2015. However, this project has never implemented. According to research of the Ukrainian Environmental League, over the last 2 years, the Ukrainian government has not been involving to environmental problems solution at all: "... the government did not have in its program of environmental component" [9].

We need to create and develop the united branch for municipal solid waste recycling. Now the waste issues (and industrial ones) are coordinated by 8 state institutions [9]. It can not be an effective decision.

**CONCLUSIONS.** Environmental problems which were created in our country by accumulated solid waste with authority attitude to the current problems are becoming a threat and require an immediate solution.

Constant tendency of MSW amount growing and its environmental damages makes us improve waste recycling and finds ways of safe treatment.

One of the advanced global tendencies concerning MSW is displacement of attention from the IPs and landfills to creation of the waste recycling facilities with garbage sorting. This way of environmentally safe and economically permissible solution may be chosen as a major for Ukraine because there is almost no the waste sorting by population.

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.

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### ЭКОЛОГИЧЕСКИЕ ПРОБЛЕМЫ МУСОРОСЖИГАТЕЛЬНЫХ ЗАВОДОВ

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Статья посвящена проблематике выбора экологически безопасного и экономически целесообразного направления обращения с твердыми бытовыми отходами в Украине.

Экологические проблемы, сформировавшиеся в нашей стране благодаря объемам накопленных твердых бытовых отходов и их непрерывному росту, приобретают угрожающий характер и требуют срочного решения. Современные тенденции переработки отходов на специальных заводах состоят в использовании высокотемпературного сжигания, в том числе в печах с кипящим слоем, послыйным сжиганием, низкотемпературной газификацией, что сопровождается мощным комплексом газоочистного оборудования. Существенной проблемой является увеличение доли полимерных отходов, которые во время сжигания провоцируют образование сверхтоксичных соединений. Анализ мирового опыта переработки отходов свидетельствует, что для государств со слабой экономикой наиболее целесообразным будет использование мусороперерабатывающих комплексов с сортировкой и утилизацией доли отходов, которая представляет собой вторичное сырье, и сжигание на мусоросжигательных заводах той доли, которая не подлежит утилизации.

**Ключевые слова:** экология, твердые бытовые отходы, мусоросжигательный завод, сортировка, утилизация.