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POSSIBILITIES OF SHAPING WASTE MANAGEMENT IN POLAND IN CONNECTION WITH THE IMPLEMENTATION OF INCINERATION PROCESSES OF THE OVERSIZE FRACTION

Michał Dziadkiewicz, Anna Jasińska, Jarosław Jan Jasiński

Czestochowa University of Technology
Faculty of Management

Abstract: The effects related to production and consumption lead to the production of significant amounts of waste. According to statistics, in Poland each of us is responsible for producing 338 kilograms of litter annually. The most popular method of waste management is landfilling due to the fact that sorting waste which may be reused is currently being promoted. However, we are not able to sort all kinds of waste into those which could be recycled later, hence the need for the construction of incineration plants that will allow a thermal decomposition of waste. The most important purpose of building an incinerator is also to minimize the landfill of waste, and then to adapt the management of the municipal waste in Poland to the European Union's waste management requirements. Therefore, in order to meet the restrictions in this area, this paper analyzes the functioning of the waste incineration plant, taking into account the processes of thermal treatment of the oversize fraction in the country, and it also shows a number of benefits arising from the compliance with requirements in line with the objectives of the 2008/98/EC Directive of the European Parliament.

Keywords: incineration plants, oversize fraction, municipal solid waste, waste incineration

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Introduction

Waste management is a difficult and at the same time superior environmental and economic problem. It is therefore important to create a system aimed at supporting measures to reduce the amount of waste produced and to manage it properly. An overriding legal act which systematizes the problem of waste is the Act on waste of 14 December 2012 (Rozporządzenie Ministra Środowiska z dnia 8 czerwca 2016 r. …, item 21). Waste prevention, disposal or recovery, as well as the reduction of waste and its negative impact on the environment are of utmost importance. The Act sets out the principles of waste management in an environmentally responsible manner and in accordance with the principle of sustainable development as well as ensuring the protection of human health and life. Over the last few years it has been noted that waste management has become a major priority in the framework of activities for the environmental protection. Having joined the EU, Poland has faced many difficulties connected

with strict requirements of the directives of environmental protection. Waste management projects should primarily involve the implementation of new systems of organizational solutions that guarantee proper management of waste streams. Another issue is the modification of waste legislation and investment in the creation of the necessary technical capacity for waste management. To a large extent, research and development should also be increased to minimize the amount of waste that is emerging. Today's economic and consumer conditions affect the amount of waste produced (*Figure 1*). Due to the restrictions imposed by the legislation of the European Union, this waste must be properly treated and disposed of (Brendzel-Skowera, Puto 2012, p. 104; Kadłubek 2016, p. 407; Jeswani, Azapagic 2016, p. 346-363). Along with the technological progress and developments in many areas of life, there have been numerous problems with waste management. An important aspect of waste management is also the ability to manage it in a variety of processes, including among other things its storage, recycling and incineration. Collecting waste has led to an increase in the amount of necessary landfills and other waste disposal facilities. This has contributed to a considerate deterioration in the sanitary and ecological situation. The European Union's environmental policy in terms of waste management is implemented on account of the strictly defined actions aiming at the implementation of effective waste management, including for example limiting landfills and using waste as natural resources and fuels. The basic legal regulation that determines the above-mentioned activities is the Directive 2008/98/EC of the European Parliament and of the Council, which lays down appropriate waste management practices and objectives in order to reduce the negative impact on the environment and human health (Directive 2008/98/EC …, Article 4 „Waste Hierarchy"). Therefore Poland, as a member state of the EU, is also obliged to implement the legal provisions within the aforementioned scope (The Act of 14 December 2012 on waste, the Act of 25 January 2013), which assume the greatest possible use in the recovery and recycling processes as well as the safe neutralization of residue, while preserving environmental safety and cost-effectiveness that are accepted by the society (Jaglarz, Generowicz 2015, p. 154-165; Seroka-Stolka, Nowakowska-Grunt, p. 366-371; Mesjasz-Lech 2013).

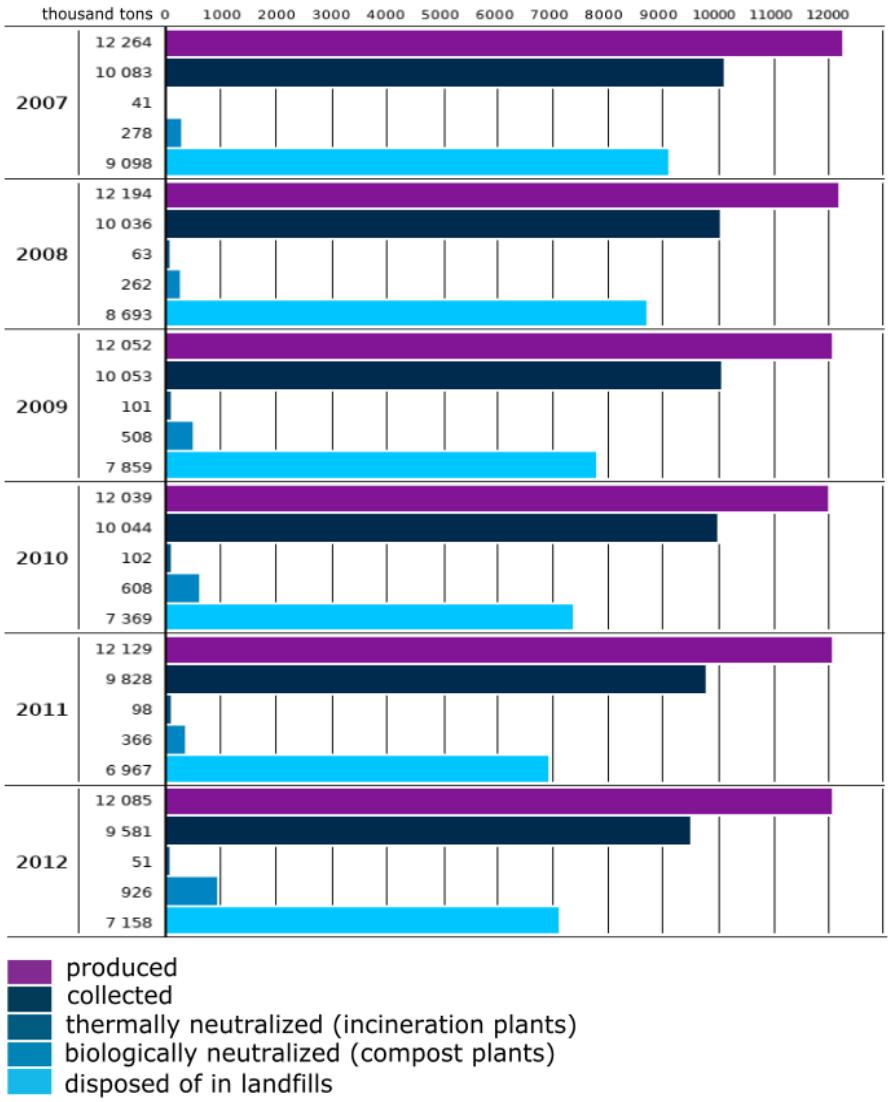

Figure 1. The amount of municipal waste produced in Poland

Source: (Styś, Foks 2014, p. 72)

Managing waste by means of incineration is more and more frequently observed. Incineration is a waste disposal method which takes place in specially designed appliances. Thermal conversion of waste occurs in the temperature between 650 and 1100°C and can be carried out in grate systems, rotary kilns or fluidized furnaces. However, the main disadvantages of the method are, among others, low efficiency of recovering electricity, generating by-products of combustion as well as installation and equipment costs (Toruński 2010, p. 31-47). A significant development of this waste disposal method took place in the 1960s as

a consequence of adopting in the EU strategies of waste management and some directives on waste disposal (1999/31/EC). As a result of this strategy, the amount of waste disposed was reduced and the number of incineration plants as well as the percentage of the incinerated waste were considerably increased in the EU countries. As the statistical data in 1990 show, about 30 million Mg of it was incinerated, whereas in 2000 it was more than 50 million Mg, and in 2007 about 62 million Mg (Wielgosiński 2010, p. 79-94). Progress in building incinerators in Poland is unfortunately insufficient and requires a distinct series of actions to meet the standards of the European Union Law and to equal other EU countries (*Figure 2*). Poland is at one of the last places in the ranking of the Member States of the European Union when it comes to the utilization of municipal waste by heat treatment (Pająk 2010, p. 137-146; Stenis 2005, p. 364).

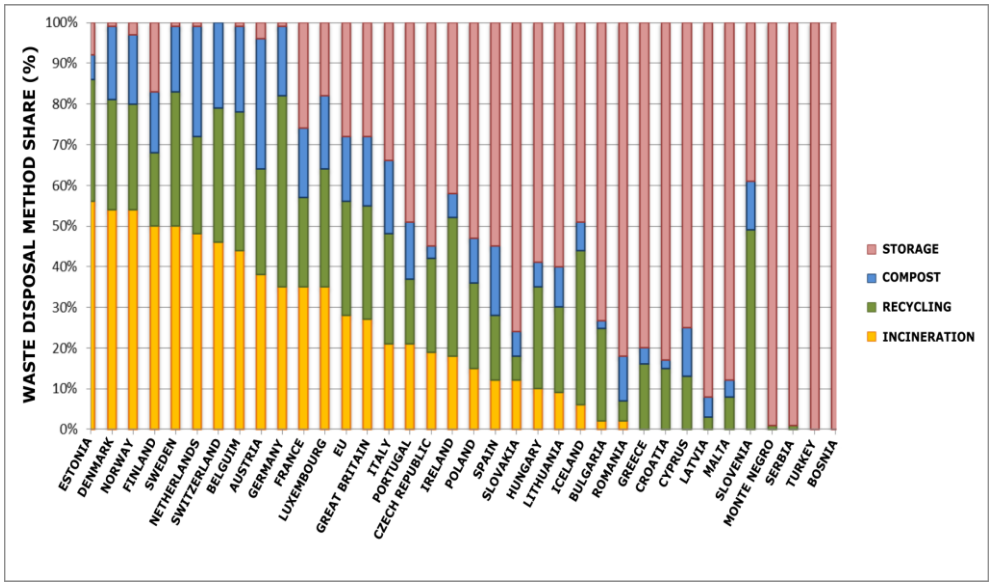

Figure 2. Participation of individual technologies of municipal waste management in selected European countries in 2014

Source: (Ziaja 2016, p. 4)

Thermal treatment processes of the oversize fraction

A research has indicated that the thermal utilization of the oversize fraction significantly reduces the size of a landfill site, as opposed to the method of waste disposal. The waste that goes to the installation of the thermal utilization of the oversize fraction is sieved on sieves. This is the first stage in which fractions, i.e. oversize and undersize ones are generated. The oversize fraction is subjected to a sorting process in the pig iron, which is then subject to recycling. Alternative fuel (RDF) is produced from residual materials. The thermal disposal of waste can be carried out in waste incineration plants and in power boilers (Strzelczyk, Wawszczak 2009). The energy generated as a result of the incineration of

municipal waste may be classified as the so-called green energy. The operation data of the installation of the mechanical-biological treatment (MBT) indicates that the oversize fraction called RDF or pre-RDF is around 40% of the initial mass of waste put into the system, which means that we can have up to 4 million Mg of calorific fraction which is separated from the municipal waste, of a net calorific value of 13-18 MJ/kg (Rozporządzenie Ministra Środowiska z dnia 8 czerwca 2016 r. …). However, RDF is waste which cannot be stored, so that it must be incinerated. The incineration of RDF is not currently cost-effective due to the need to rebuild the system to meet the formal and legal requirements of the incineration process. It will be more profitable to build specially adapted installations. An example of the problem can be the construction of a thermal waste treatment plant in Olsztyn. In the initial stage, there were plans to build a plant of a capacity of about 100 thousand Mg/year. However, the city authorities resigned from the construction of the incinerator for the construction of a combustion plant of a capacity of about 130 thousand Mg/year. However, during the approval of the EU project there was a problem which raised the question of what should be done with 50 thousand of Mg of RDF per year. So it was decided to build an RDF combustion plant of a capacity of about 50 thousand Mg/year. Yet, at the design stage it was decided that the combustion plant would still take waste from other MBT plants in the voivodeship, and its capacity would be raised to about 100 thousand Mg/year (Wielgosiński, Namiecińska 2016, p. 11-20).

We distinguish two essential technological solutions to improve the quality of fuels obtained from waste. The first one, the aforementioned mechanical-biological treatment (MBT) is based on selecting raw materials of high calorific value, whereas the second one, connected with waste processing, is biodrying. High quality RDF fuels are obtained from materials of high calorific value, and therefore they must be characterized by reduced humidity and high heat of combustion. Therefore, the quality of fuels can be significantly improved by various technological solutions e.g. additional drying of waste in order to increase its calorific value. The biodrying technology is more and more frequently used for the mechanical and biological treatment of waste. It has a number of conveniences, including the possibility of obtaining a greater amount of fuel from waste which, after initial grinding, is subjected to drying in closed reactors. The material is then sorted into light and heavy fractions. Biodrying is thus mainly based on removing moisture from waste. Energy obtained from biochemical processes occurring in waste is helpful in this process. In companies using the MBT technology, it is based mainly on the biostabilization of waste fuel, which is separated from the coarse oversize fraction (> 100 mm or > 80 mm). This fraction contains large amounts of combustible components of high calorific value. Components that can be extracted for the production of fuel might also come from the middle fraction. This fraction, however, will require drying in order to increase its calorific value (den Boer 2013).

The results of the study show that meeting the process requirements in power boilers is not easy and requires separate analysis each time. Particularly the condition of keeping waste at a given temperature for 2 seconds might be difficult

to achieve with low-emission combustion with lower temperatures in boiler furnaces, especially fluidized ones. Also, load changes may lower the flue gas temperature or reduce their time at a given temperature (*Figure 3*).

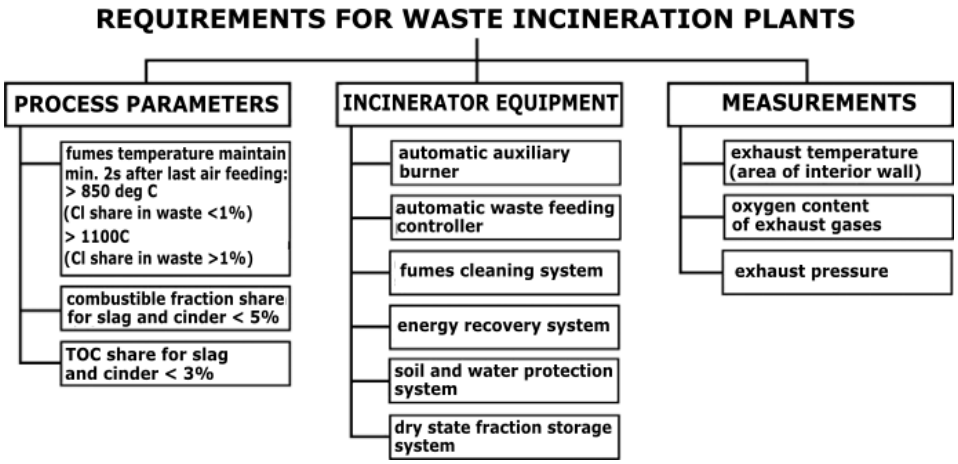

Figure 3. Requirements for waste incineration plants

Source: (Kotlicki, Wawszczak 2011, p. 160)

Economic and territorial conditions for the construction of an incineration plant

Waste management, and in particular the waste incineration method has been perceived in a negative way for many years, because it is difficult to obtain social acceptance for the aforementioned method of waste disposal. Although in many countries of the European Union thermal methods of municipal waste management account for about 30-60% of all the used methods of management in terms of tonnage, yet still in many countries, including Poland in particular, waste incineration raises many concerns and becomes a field of open conflicts between local governments and groups of residents, and as a result local governments often abandon this method of waste management (Wielgosiński 2010, p. 80; Miezah et al. 2015, p. 15-27). It is not without significance for social acceptance and it seems that it is not unjustified for the inhabitants of the areas where waste incineration plants are planned to be afraid of the negative impact of those installations on the health of people who live nearby municipal waste incinerators as well as the workers of those plants. Although an estimated analysis of chemical hazards emitted by municipal waste incineration plants, carried out against the background of valid values of permissible concentrations, indicates no significant health risk, yet the conclusions coming from the detailed study are not so optimistic. Blood and urine tests of the employees of municipal waste incineration plants as well as people living near those plants have indicated an exposure to various organic and inorganic substances (Starek 2004, p. 24-26). Results of the research conducted in the Netherlands indicate in exposed persons an increase in average concentrations

of heptachloro- and octachlorodibenzodioxin as well as hexachloro- and heptachlorodibenzofuran in the blood of the workers of municipal waste incinerators in relation to those who live nearby but do not work in the incineration plant (van der Hazel, Frankort 1996, p. 119-121). On the other hand, some German studies have shown that in case of workers who directly operate waste incineration furnaces, the concentrations of lead, cadmium and toluene in the blood and arsenic and tetrachlorophenols in the urine were considerably higher than in other employees of the plant, but did not exceed the limits of biological concentrations in Germany (Wrbitzky et al. 1995, p. 13-21; Seroka-Stolka 2014, p. 302-309). In general – according to A. Starek – the findings of studies carried out in a few European countries indicate the existence of occupational and environmental exposure to many toxic substances emitted by municipal waste incineration plants. At the same time, he points out the risk that the use of municipal waste incinerators of older generations brings with it (Starek 2004, p. 25). The development of the thermal method of municipal waste management, however, opens up optimistic perspectives concerning the potential environmental and occupational harmfulness of the operating municipal waste incineration plants. The directions for modernization of plants predict an increase in their efficiency, reducing the level of exhaust emissions, including substances such as nitrogen oxides (Rizzon 2016, p. 39; Gonzalez-Benito, Gonzalez-Benito 2006, p. 87-102).

The primary aim of the construction of an incinerator is to reduce the mass and volume of waste. Good practices from other EU countries show many benefits from waste incineration, as it is an indispensable component of the waste management system. In Poland there are 6 waste incineration plants (operating or scheduled for operation), among others in Bydgoszcz, Bialystok, Cracow, Konin and Poznan, and at the end of 2017 it is planned to start the operation of a new plant in Szczecin (*Figure 4*).

CITY	TOTAL BUILDING COST OF INCINERATOR (NETTO PLN)	INCINERATOR PRODUCTIVITY (THOUSAND TONS)	EXPENDITURE (PLN/T)
BIAŁYSTOK	OK. 333 MLN	120	2 775
BYDGOSZCZ	OK. 426 MLN	180	2 367
KONIN	296 MLN	94	3 149
KRAKÓW	OK. 673 MLN	220	3 059
POZNAŃ	725 MLN	210	3 452
SZCZECIN	OK. 580 MLN	150	3 867
AVARAGE (ROUNDED)			
	505 MLN	162	3 111

Figure 4. Productivity of waste incineration plants in Poland

Source: (Kinitz 2014)

Currently, there are trends in the country to build regional municipal waste treatment installations, and more and more municipalities and counties are planning to have their own installation. It is important, however, to demand that the new incineration plants are designed for the utilization of the RDF fraction. At present, only incineration plants in Szczecin and Gdansk were designed under the possibility of the technological utilization of RDF (Wielgosiński 2011, p. 55; Nowakowska-Grunt 2014, p. 789-795). This is directly connected with the cost of the waste incineration process, which in most countries of the European Union amounts to from 60 to 120 EUR / 1 Mg, in Poland about 280 zloty / 1 Mg (Wielgosiński, Namiecińska 2016, p. 20). It follows from the data on the estimated amount of waste utilization planned for the years 2016-2020 that in order to obtain greater profitability and effectiveness of waste management, another 5 waste incineration plants and about 12 combustion plants of alternative fuel produced from RDF waste should be implemented in the country. The most modern municipal waste incinerators, due to the use of technologically advanced systems of gas purification, as well as the appropriate management of secondary waste allow their mass to be reduced to about 8% of the original mass. As a consequence, the area to be developed into landfill sites is reduced. Among the significant benefits coming from the implementation of the method of waste disposal in the form of incineration is a substantial reduction of organic waste, which directly affects an increase in the greenhouse effect. In addition, it is worth mentioning that waste incineration protects people and the environment from the ingress of large amounts of toxins leached from waste by rainwater (downpours, floods etc.). Another important benefit of waste incineration is its energy properties. Storage, as well as composting, is a huge loss of energy properties of waste, since from burning 1Mg of waste we may recover as much as 500 kW of energy (Wielgosiński, Namiecińska 2016, p. 20). The major problems which plants have to face are those related to the management of the energy fraction obtained from waste. In case of incinerators, the main problem is its small amount, since they are hard to access or not available in most regions. Transport charges and charges for giving the energy fraction to the incineration plant are also a problem. Therefore, in the near future plants will have to choose between the production of a high RDF / pre-RDF calorific value or the recovery of all raw materials, as it is impossible to produce high-energy coal and conduct recovery at a high level from the same stream. It is also worth mentioning that the Scandinavian market, where technologies of thermal treatment of waste are highly developed, is becoming a big chance for production plants located particularly in the north of the country. That is why the aforementioned market shows a great need for the acquisition of the energy fraction for its own incineration plants, which are often the only source of heat and energy for the city. On the other hand, Polish law still requires the fulfillment of numerous standards and formalities in particular bank guarantees connected with the cross-border transport of waste, as well as the costs that charge the shipper of the batch. Thus, the overriding objective is to solve the problem of the fraction of energy through cooperation with incineration plants, cement works and also foreign markets. The best solution would also be to expand incinerators

beside production plants, or special zones of waste management, thanks to which energy waste could supply the regions with electricity and heat (Spodzieja 2013).

Conclusions

To summarize the above considerations, it should be noted that the main lines of activity in the sphere of waste management were defined by the countries of the European Union many years ago. The primary and main goal is to reduce the number of landfills and to maximize the use of waste in the recycling of raw materials and materials for energy production (Starostka-Patyk, Grabara 2010, p. 16). One of the main priorities in the country should be to build a waste management system in line with the requirements imposed by the community of the European Union, also largely based on the thermal waste disposal. A significant improvement in the situation can be noted, yet investments related to the purchase or implementation of original installations for the incineration of the oversize fraction are still needed. One of the main obstacles to the development of the aforementioned waste incineration technology is also the so-called resistance of the society, associated with the conviction that waste incineration is a technology which emits harmful pollution. However, in view of the increase in the requirements resulting from Poland's membership to the European Union, as well as the emergence of a growing problem with the acquisition and management of areas intended for landfill sites, it seems that changes in waste management in terms of its incineration at a level assumed by the Directive 2008/98/EC are inevitable. The first changes in the national waste management have already been implemented by the so-called garbage revolution, however, there is still a big problem of burning garbage in unsuitable home appliances and illegal landfills in uninhabited areas (Ulfik, Nowak 2014, p. 1043). Therefore, it can be stated that incineration is an extremely important part of the waste management system, but we should remember that waste management is mostly based on the preparation of raw materials for reuse (recycling), whereas in the second place, technologies that dispose of waste but allow for energy recovery (incineration) are used.

The superior and prospective effect of building incineration plants and implementing incineration is above all adjusting the waste management system in Poland to the requirements of the EU. Waste incineration should, however, be carried out in technologies that are particularly stringent from the point of view of possible health risks, both these of a professional nature, concerning employees who operate incinerators, as well as environmental risks related to the inhabitants of the areas nearby incineration plants.

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MOŻLIWOŚCI KSZTAŁTOWANIA ZARZĄDZANIA GOSPODARKĄ ODPADAMI W POLSCE ZWIĄZANE Z REALIZACJĄ PROCESÓW SPALANIA FRAKCJI NADSITOWEJ

Streszczenie: Efekty związane z produkcją i konsumpcją prowadzą do generowania znaczących ilości odpadów. Według danych statystycznych w Polsce każda osoba rocznie produkuje 338 kilogramów śmieci. Najpopularniejszą metodą zagospodarowania odpadów jest ich składowanie, ponieważ obecnie propaguje się segregację odpadów, które mogą zostać ponownie wykorzystane. Natomiast nie wszystkie odpady jesteśmy w stanie posegregować na takie, które w późniejszym czasie mogą zostać poddane recyklingowi, w wyniku czego występuje zapotrzebowanie na budowę spalarni odpadów pozwalających na termiczne likwidowanie odpadów. Najważniejszym celem budowy spalarni jest również zminimalizowanie składowania odpadów, a co za tym idzie – dostosowania gospodarki odpadami komunalnymi w Polsce do wymogów określonych przez Unię Europejską odnoszących się do zagospodarowania odpadów. Dlatego też, w celu sprostania restrykcjom w tym zakresie, w artykule dokonano analizy funkcjonowania spalarni odpadów z uwzględnieniem procesów termicznej utylizacji frakcji nadsitowej w kraju, jak również ukazano szereg korzyści wynikających z realizacji wymogów na poziomie zgodnym z założeniami dyrektywy Parlamentu Europejskiego 2008/98/WE.

Słowa kluczowe: spalarnie, frakcja nadsitowa, odpady komunalne, spalanie odpadów