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Mercury content in refuse-derived fuels

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Abstract: The paper presents the results of testing the mercury content in fuels derived from different types of waste. Legal and technical issues related to preventing mercury from getting into the environment are taken into account with respect to refuse-derived fuels used in cement plants. The mercury content in refuse-derived fuels is usually smaller compared to conventional fossil fuels such as coal. For this reason, the requirement imposed on the fuel suppliers that it must not exceed the limit of 0.3 ppm (in dry matter (DM)) seems over-restrictive and unjustified. The paper presents the sources of mercury contamination of waste with attention drawn to the significance of selective waste collection and the need to educate the public in this area. Presented are results of the testing of the mercury content in waste types characterized by a great variation of the parameter depending on the origin of the waste combustible fractions and their possible contact with waste containing mercury. Depending on the fuel origin (ballast from selective collection of waste, residue from mixed municipal waste sorting, bulky waste, car industry waste, sewage sludge), the average content of mercury in the fuels under analysis is included in the range of 0.1–1.15 ppm (DM).

Introduction

The management of municipal and industrial waste, with special account taken of recycling and other methods of waste recovery, including recovery for energy purposes, is a priority in the modern waste management system. According to the European Union hierarchy of handling waste, the first to be recovered are the waste fractions which are valuable and suitable for material or chemical recycling. However, considering that not all fractions can be recycled and knowing that sorting efficiency has its limits, sorting residues still include a high combustible fraction which may be used as input for the production of refuse-derived fuel. Utilization of refuse-derived fuels in cement plants and combined heat and power plants is a perfect embodiment of the circular economy concept and the "zero-waste" strategy.

In 2016, about 1,25 million Mg of refuse-derived fuels from combustible fractions of municipal and industrial waste were used in Poland, which makes Poland one of the European Union leaders in this category (Szweda 2017).

The fuel is purchased by cement plants, which, in view of the fuel oversupply on the Polish market and due to the fact that it has already hit the ceiling on use, impose increasingly demanding requirements and want lower prices. Therefore, if production of the refuse-derived fuel from sorting residues is to be ventured, ensuring a market for the product and the process profitability have to be taken into consideration. The situation on the market of refuse-derived fuels in Poland could be improved by engaging heat and power plants in utilizing them, which is the case in Scandinavia, Germany or Italy. The industry of using refuse-derived and solid recovered fuels is developing in heat and power plants equipped with state-of-the-art fluidized bed boilers, and investments are being made also beyond Europe, e.g. in Korea.

First such investment in Poland is planned in the Zabrze combined heat and power plant, where a new cogeneration unit is now being developed. The investor is the Fortum company and the circulating fluidized bed boiler will be delivered to the CHP plant by the Amec Foster Wheeler company. The Zabrze combined heat and power plant will be fired with coal, refuse-derived fuel and biomass.

ERFO (European Recovered Fuel Organisation) is a non-profit association, founded in 2001 by European companies producing recovered fuels. ERFO was established to develop the concept of Solid Recovered Fuel (SRF). SRFs are solid fuels prepared from non-hazardous waste to be utilized for energy recovery in incineration or co-incineration plants and meeting the classification and specification requirements laid down in the EN15359 European standard. ERFO's main aim is to promote the production and use of recovered fuels, and especially SRF, in Europe. To that aim, ERFO supports standardization of SRF and participates in research projects.

ERFO participates in European political debates concerning policy and legislation related to SRF and has publication achievements (ERFO).

According to the European Waste Catalogue, refuse-derived fuels are classed as waste marked with code 191210 (combustible waste), but they have to meet restrictive requirements of the cement plant. For this reason, in order to control the product quality, an RDF manufacturer should have its own laboratory. The fuel selected parameters can also be controlled systematically using specialist sensors in the manufacturing plant or in the cement plant (such sensors are offered by the Tomra Sorting company, for example).

The application of the refuse-derived fuel in cement kilns is beneficial to the environment – it prevents depletion of natural fuel resources and causes no ash or slag to remove. It is beneficial both to society, as it involves a smaller need to invest in the construction of new and costly incineration plants, reduces the amount of landfilled waste and ensures realization of the energy recovery process, and industry – owing to reduced production costs and increased competitiveness (Sładeczek 2012).

The chemical composition of refuse-derived fuels co-fired in a cement kiln may have a substantial impact not only on the obtained clinker quality but also on the operational stability of the kiln installation. Due to that, RDF's are subject to restrictions concerning their content of alkalis, chlorine, fluorine and heavy metals, including mercury (Polish Cement Association 2008).

The properties of currently produced refuse-derived fuels are similar to those of conventional fossil fuels such as hard coal and in many cases they are even better. One of the requirements imposed by cement plants on the RDF is the content of mercury. The power and cement industries are a major source of mercury emissions. Metal compounds are fed into the cement kiln with raw materials, together with the fossil fuel and the RDF. Mercury is the most volatile metal. A reduction in mercury emissions into the atmosphere can be achieved by reducing the element content in the substrates and fuels fed into the cement kiln, and this requires controlling the mercury volume fed into the kiln installation.

Legal and technical issues related to preventing mercury from getting into the environment in the context of refuse-derived fuels used in cement plants

Cement plants using refuse-derived fuels have to comply with the emission limits set out in the Regulation of the Minister of the Environment of 4 November 2014 on emission standards for certain types of installations, fuel combustion sources and devices for firing or co-firing of waste (Journal of Laws 2014, item 1546). In the case of cement kilns used to produce clinker which are co-fired with waste, the emission standards for mercury total 0.05 mg/m^3_u at a 10% content of oxygen in flue gases.

Within its scope, the above-mentioned regulation implements, among others, Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions. The Industrial Emissions Directive (IED) replaced seven binding directives, including the Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control (IPPC), with a single legal act whose main task is to reduce the negative impact of industrial installations on the environment and, among others, to impose stricter restrictions on allowable values of emissions for combustion plants.

The now binding European regulations concerning co-firing of waste include the best available techniques (BAT) specified in the BAT reference document for the cement and lime industry (BAT 2010).

Through the Industrial Emissions Directive the role of the best available techniques has been strengthened. Before the Directive was adopted, the reference documents specifying the BAT had been used as guidelines and instructions for entities issuing relevant permits. Now the BAT conclusions are legally binding. They lay down the requirements that installations have to comply with within 4 years as of the date of publication of decisions on BAT conclusions. In March 2013 the BAT conclusion for cement, lime and magnesium oxide was adopted (BAT conclusions – production of cement 2013).

Mercury is released into the atmosphere both from natural and anthropogenic sources. It is estimated that half of the mercury contained in the atmosphere at present is of anthropogenic origin.

It is now the power industry that is responsible for the highest emissions of mercury into the air in the European Union. In 2013 mercury emissions from the cement and lime industry plants reached 11% of the total emissions in the EU-27 (E-PRTR 2013).

The ongoing measurements of mercury emissions from clinker burning installations indicate that in the European Union they are at the level of 0.01–0.05 mg/Nm^3. Flue gases primarily contain elemental mercury (Hg^0), mercury ions (Hg^{2+}) and mercury adsorbed on the surface of ash particles (Hg(p)) (Głodek and Sładeczek 2012).

Mercury is considered as one of the most toxic substances posing a hazard to the environment and being a threat to human health. For this reason, in 2009 the Governing Council of the UN Environment Program decided to commence works on a new international legal instrument. The name of the convention – the Minamata Convention on Mercury – comes from a Japanese city of Minamata, where in the mid-20th century thousands of inhabitants were poisoned with mercury due to the release of industrial wastewater from a chemical factory. On 24 September 2014 in the UN Headquarters in New York the convention was signed by more representatives of governments and countries, including Poland. The aim of the convention is comprehensive protection of the environment and human health from the adverse effects of mercury getting into the atmosphere, water and soil. It also aims to eliminate mercury from products and industrial processes. The convention also establishes rules of environment-friendly management of waste containing mercury, addresses the application of appropriate methods of mercury storage and regulates issues concerning sites contaminated with the metal.

The project concerning guidelines on the best available techniques and the best environmental practices for installations emitting mercury into the atmosphere (in the light of the regulations of the Minamata Convention on

Mercury) is the subject of the UN Environment Program public consultations.

One of the projects already completed in relation to the Minamata Convention is the developed set of guidelines for the cement industry (BAT-BEP, cement clinker production 2015).

The limits imposed by Polish cement plants on the mercury content in the refuse-derived fuel now vary in a rather wide range of 0.3–0.5 ppm (DM). The plants carry out tests of the material sampled and averaged from a delivered lot of refuse-derived fuels during three or five days.

In the cement industry, mercury is fed into the rotary kiln system together with the raw material and fuels. Due to the fact that mercury is highly volatile, most of the metal is emitted into the air and only a small part is immobilized in clinker. The paper (Głodek and Sładeczek 2012) presents the current state of knowledge of mercury circulation in the cement kiln system.

A typical range of the mercury content in conventional fuels and in RDF's in cement plants is presented in Table 1.

It follows from the table presented above that the range of the content of mercury in the refuse-derived fuel used to make clinker is often smaller compared to the conventional fossil fuel such as coal, where the content can be as high as 4.40 ppm (DM). For this reason, the requirement imposed on suppliers of the refuse-derived fuel that the mercury content must not exceed the limit of 0.3 ppm (DM) seems over-restrictive and unjustified.

It should also be remembered that the RDF composition may vary considerably and in some fuel lots mercury can occasionally reach the concentration of 1 to 10 ppm instead of the assumed range of 0.1–0.4 ppm (Genon and Brizio 2008).

This is why selective collection of hazardous waste containing mercury is so important. It is also essential that the RDF properties are controlled both at the stage of production (in the RDF manufacturer's laboratory) and at the stage of the fuel acceptance by the cement plant (in the plant's laboratory).

In (Genon and Brizio 2008) the tested 50/50% mixture of the RDF and coal used for clinker burning causes maximum emissions of mercury at the level of 0.04246 mg/Nm^3 in the cement plant. If coal only is used for this purpose, the emissions are higher and reach the level of 0.07588 mg/Nm^3. This suggests that the application of refuse-derived fuels has a beneficial environmental effect due to smaller emissions of mercury.

Paper (Nasrullah et al. 2015) presents the elemental balance of production of the solid recovered fuel, i.e. fuel produced from commercial and industrial waste by mechanical treatment. Of the total mercury content in the fuel production input material, 45% was found in the SRF stream, 30% – in the reject material and 25% – in the sieve residue fine fraction. No mercury was found in a heavy fraction. Half (51%) of the total load of mercury in the input waste stream was what is referred to as soft plastics.

Table 2 presents the results of a laboratory elemental analysis of commercial and industrial waste components with respect to the content of mercury (Nasrullah et al. 2015).

Table 3 presents the content of mercury in different fractions arising in the SRF production process (Nasrullah et al. 2015).

Table 1. Mercury content in fuels used for clinker production in cement plants

Fuel	Source of data	Hg ppm (DM)
Coal	(Genon and Brizio 2008)	**0.02–4.40**
Petroleum coke	(Genon and Brizio 2008)	0.02–0.1
RDF, SRF	(Genon and Brizio 2008)	**0.1–0.4**
Liquid refuse-derived fuel	(Głodek and Sładeczek 2012)	<0.06–0.22
Sewage sludge	(Głodek and Sładeczek 2012)	0.31–1.45
Tyres:	(Głodek and Sładeczek 2012)	0.01–0.40

Table 2. Mercury content in individual industrial and commercial waste components used for SRF production

Element	Unit	Paper and cardboard	Plastics (hard)	Plastics (soft)	Textiles	Rubber	Foam	Wood	Fine fraction
Hg (mercury)	mg/kg (DM)	< 0.05	0.05	0.1	0.2	0.08	0.2	< 0.05	0.3

Table 3. Mercury content in different fractions arising in the SRF production process

Element	Unit	Input waste stream (commercial and industrial waste)	Reject material fraction	Fine fraction (sieve residue)	SRF fraction
Hg (mercury)	mg/kg (DM)	0.1	0.2	0.4	0.1

A uniform classification system for solid recovered fuels (SRF's) was developed by the European Committee for Standardization (CEN). Under the CEN system, SRF's may be produced from non-hazardous waste only and applied exclusively in installations meeting technical and emissive standards established for refuse material co-firing. The input material for the SRF production process includes industrial, commercial and municipal waste, waste collected selectively, and construction and demolition waste. The fuel can be composed of selected fractions of plastics, paper, cardboard, textiles, rubber and wood. The classification system proposed by the CEN is based on three key and equivalent parameters that define the SRF properties: calorific value, chlorine content and mercury content. The parameters determine three aspects of assessment related to the fuel use: economic, technological and emissive. Each of them is assigned 5 quality classes, with limit properties established for each class. A combination of the class numbers determined for each of the three parameters gives the fuel classification code. The guidelines also recommend that individual parameter values should be established taking account of statistical principles and a strictly defined testing frequency as specified below (Sobolewski et al. 2007):

- for the net calorific value (NCV [MJ/kg], as-received state) – arithmetic mean,
- for the content of chlorine (Cl [%], dry state) – arithmetic mean,
- for the content of mercury (Hg [mg/MJ], as-received state) – the median and the 80th percentile.

Table 4 presents the ranges of qualification parameters adopted by the CEN for SRF's according to the CEN technical specification TS 15359 [Technical Specification CEN/TS 15359:2006] EN 15359:2011 (WI=00343042) Solid Recovered Fuels – Specifications and classes, in Poland implemented as Standard PN-EN 15359:2012. In the case of data concerning the mercury concentration, the higher of the two statistical values is applied for the fuel classification. The main objective of the SRF code classification developed by the CEN is to offer a method of fuel identification that will be useful in contacts between the fuel manufacturer and receiver. These are of course only selected parameters defining the fuel properties which are essential from the receiver's perspective. It is very often necessary to provide a detailed characteristic through parameter specification, in compliance with the template annexed to the CEN/TS 15359 technical specification (Annex A).

Refuse-derived fuels are popular not only in the EU or Scandinavia. Waste management scenarios based on the production and utilization of RDF's are also analysed beyond Europe in countries such as Canada, for example. The paper (Reza et al. 2013) presents a waste management case study for the Metro Vancouver Regional District (Canadian province of British Columbia, population of 2.3 million). It includes an analysis of environmental and economic aspects of the production and utilization of the RDF as an alternative fuel for cement plants. A comprehensive assessment of the environmental impact was carried out using the life cycle assessment (LCA) method. The economic aspects were investigated by means of the cost-benefit analysis (CBA). The results confirm that production of the refuse-derived fuel and its utilization in cement kilns is a profitable solution for the Metro Vancouver district both environmentally and economically.

In (Samolada and Zabaniotou 2014) a SWOT (Strengths--Weaknesses-Opportunities-Threats) analysis is conducted to compare two scenarios of the solid recovered fuel utilization in an existing cement plant and in a special combined heat and power plant. The results of the comparison favor the fuel utilization in the cement plant.

In (Wagland et al. 2011) a comparison is made between the process of combustion of coal co-fired with a 10% addition of the SRF and coal with a 10% addition of the RDF in a fluidized bed reactor. An analysis is conducted of the distribution of heavy metals, including mercury, in ash and flue gases. The results indicate that most mercury, unlike the other heavy metals, is released into the flue gases (~90%) and ~10% is released into the ash, including fly ash, which proves the metal high volatility. The mercury concentration in the SRF textile and paper fractions was identical: 0.05 mg/kg (DM), whereas for sawdust it totaled 0.04 mg/kg (DM). The increased concentration of Hg, Zn, Cd, Pb, Cr in the RDF points to the presence of hazardous components, such as batteries, cosmetics or paints, for example.

Content and origin of mercury in municipal waste

In (Hławiczka and Cenowski 2013) the anthropogenic processes generating solid mercury-containing waste are systematized. The following process groups are distinguished:

- manufacture and utilization of products containing mercury
- waste incineration/combustion.

Mercury-containing products must be treated as a potential source of the metal in solid waste. Table 5 presents data concerning the consumption of mercury as a component used

Table 4. Solid recovered fuels – technical requirements and classes

Classification parameter	Statistical measurement	Unit	Class				
			1	2	3	4	5
Net calorific value (NCV)	mean value	[MJ/kg] – as-received state	≥ 25	≥ 20	≥ 15	≥ 10	≥ 3
Chlorine (Cl) concentration	mean value	[%] – dry state	≤ 0.2	≤ 0.6	≤ 1.0	≤ 1.5	≤ 3
Mercury (Hg)	median	[mg/MJ] – as-received state	≤ 0.02	≤ 0.03	≤ 0.08	≤ 0.15	≤ 0.5
concentration	80th percentile	[mg/MJ] – as-received state	≤ 0.04	≤ 0.06	≤ 0.16	≤ 0.30	≤ 1.0

to make different products, with a division into 3 geographical areas (Hławiczka and Cenowski 2013).

No such investigation into the consumption of mercury has been carried out in Poland yet.

Apart from the items listed in the table above, more mercury-containing products should be mentioned: cosmetics, paint preservatives and medicines. Once they become waste, the products should be selectively collected and disposed of appropriately. Unfortunately, some of them get into municipal or industrial waste, which makes it difficult to predict or estimate the level of mercury contamination of the combustible fraction of the material used for the RDF production.

It sometimes happens that municipal waste contains batteries, energy-saving bulbs and mercurial thermometers.

A report of the State Inspectorate of Environmental Protection indicates that in 2014 Poland failed to achieve the required levels of selective collection of batteries and portable accumulators. Considering the rise in the requirement level to 45%, it is rather dubious that this condition will be satisfied.

In 2014, 8273.61 kg of mercury-containing button batteries were placed on the Polish market (Report 2015).

Mercury is also present in the control and measurement apparatus, for example, in devices such as thermometers, barometers and pressure valves, as well as in manometers and blood pressure meters. The mercury content in a single device mentioned above is as follows: in a thermometer – from 1 to a few hundred grams, in an average blood pressure meter – ~70 g, in a barometer or a manometer – from 70 to 140 g, in a pressure valve – from 100 to 600 g. The mercury content in a single piece of lighting equipment is of the order of several to a few dozen milligrams. The progress in technology has made it possible to substantially reduce the content of mercury in lighting equipment. Old lamps, which unfortunately are still in common use, contain the following amounts of mercury: neon displays in street lighting devices – from 500 to 2500 mg Hg/lamp, UV lamps used for illumination/light therapy, e.g. in beauty parlors – from 15 to 40 mg Hg/lamp, high-intensity lighting lamps (intended for outdoor use) from 20 to 70 mg Hg/lamp, sodium vapor lamps – from 9 to 20 mg Hg/lamp. Glow-tube lamps, which also contain mercury, are still used today as lighting devices. They are more energy-efficient compared to traditional lighting equipment but they are characterized by one essential disadvantage – withdrawn from use they pose a serious problem to the environment. An analysis of possible lighting technologies indicates that it is technically feasible to make lamps with the mercury content lower than 4 mg Hg/lamp, which is a single lamp limit that should characterize the best available technology (BAT) of the production of glow-tube lamps. In Poland, the problem of the mercury content in different kinds of waste remains practically unidentified (Hławiczka and Cenowski 2013).

The fact that mercury and fluorine occur simultaneously in mixed municipal waste and in the waste sieve residue samples proves that both fluorescent lamps and energy-saving lamps containing mercury are thrown into rubbish bins intended for mixed waste. This practice is additionally confirmed by vitrification of mixed municipal waste samples during tests aiming to identify ash phase changes.

The co-occurrence of mercury and fluorine in mixed municipal waste is remarkable because it is also solid proof that the extent of selective collection of worn-out lamps containing mercury (including energy-saving lamps) is rather limited.

Due to the identified higher content of mercury, the production line of fuels made from mixed municipal waste should implement solutions eliminating fine fractions of glass (Czajka 2013).

Materials and methods

Reference methodology for mercury qualification in refuse-derived fuels – the testing procedure

Despite the fact that, under the Regulation of the Minister of the Environment on the waste catalogue, refuse-derived fuels are still classed as waste, they have to meet a number of requirements concerning physiochemical properties specified by the purchaser. Therefore, in order to maintain appropriate standards, the Starol company has its own laboratory to examine both the delivered waste and the refuse-derived fuels. The waste variety and its changeable composition make it necessary to monitor waste in terms of its physiochemical parameters. The monitoring is also a tool to protect the installation against undesirable events. Laboratory control guarantees the composition stability of the refuse-derived fuels used in cement plants.

The content of mercury is one of the specially monitored parameters. Depending on the receiver of the fuel, the limit concentration varies from 0.3 ppm to 5 ppm. As a professional

Table 5. Mercury consumption (Mg) for the production of selected materials and equipment in 2000

Process/product	Worldwide (total) [Mg]	EU countries – 15 [Mg]	USA [Mg]
Production of batteries	1081	15	16
Dental materials	272	70	44
Control and measurement apparatus	166	26	35
Lighting equipment	91	21	17
Electrical switches and relays	154	25	50
Other products	175	50	50
Total	1939	207	212

refuse-derived fuel producer, the company Starol monitors the parameter in its own laboratory. The analysis is performed according to an in-house testing procedure using the Nippon Instruments Corporation MA-2 mercury analyzer.

The detector operates using the principle of cold vapor atomic absorption, which is described by the Lambert-Beer law.

The value of the logarithm of the falling-to-passing light ratio is proportional to the concentration of the mercury vapors.

The MA-2 analyzer is intended for measurements of the mercury content in solid, liquid and gaseous samples, without the need for the sample prior mineralization. The detection limit is 0.005 ng Hg. The carrier gas is purified dry air. The device is composed of a mercury analyzer and a personal computer.

The samples placed in the analyzer are automatically screened to detect the mercury content. The sample under analysis is thermally decomposed in the analyzer decomposition furnace. Mercury is then atomized and the released mercury vapors are absorbed in a gold amalgamator to produce the amalgam. Next, the amalgam is heated to release atomic mercury, which is qualified in the absorption chamber by means of the cold vapor atomic absorption spectrometry at the wavelength of 253.7 nm.

Results and discussion

Table 6 presents example results of the analysis of a refuse-derived fuel lot dispatched to a selected cement plant. The parameters indicated in the table are of great significance for the process of the fuel co-combustion in the cement kiln. They affect both the cement burning process stability and the emissive parameters. The mercury content is given in two places – as the element itself and as a constituent in the total amount of metals, together with thallium and cadmium.

Impact of the waste origin on the content of mercury in RDF's

The fact that the RDF manufacturer has its own laboratory creates a great opportunity in terms of testing a wide spectrum of different kinds of waste. Table 7 presents example results of testing the mercury content in fuels made from different refuse materials. The results are an average value of testing a great number of samples of fuels derived from different kinds of waste.

Conclusions

The performed analysis of a wide spectrum of fuels made from different kinds of waste leads to conclusions which are of great importance from the perspective of the production of refuse-derived fuels and their mercury content. The conclusions are listed below.

- Fuel production from the ballast of selective collection of waste (plastics, paper and cardboard) does not involve the risk of exceeding the limits of the mercury content in the produced fuel. This results from the fact that mercury-containing materials are generally not found in waste collected selectively.

Table 6. Results of the analysis of an example RDF lot dispatched to a selected cement plant

Results of the analysis of an example RDF lot dispatched to a selected cement plant			
UNIT RESULTS		PERIODIC RESULTS	
Net calorific value [kJ/kg]:	18620	Hg [ppm]:	0.23
Chlorine content [%]:	0.55		
Ash content [%]:	4.8	Hg+Tl+Cd [ppm]:	7.2
Total sulphur concentration [%]:	0.25		
Moisture content [%]:	14.7	Ni+Pb+Cu+Sb+As+Co+V+Mn+Cr [ppm]:	757
Bulk density [g/cm^3]:	0.16		
Grain size [mm]:	< 30		

Table 7. Results of the analysis of the mercury content in a refuse-derive fuel lot dispatched to a selected cement plant

Type of waste from which the fuel was derived	Unit	Average	Minimum	Maximum	Median
Ballast from selective collection of waste	mg/kg (DM)	0.10	0.01	0.19	0.09
Unsorted municipal waste	mg/kg (DM)	0.47	0.01	6.37	0.32
Bulky waste	mg/kg (DM)	1.15	0.04	11.31	0.23
Car industry waste	mg/kg (DM)	1.12	0.42	2.34	0.97
Sewage sludge	mg/kg (DM)	0.65	0.07	4.12	0.31

- In the case of mixed and bulky municipal waste, a much greater variation in the parameter can be observed. In extreme cases, the waste is disqualified to be fed into the fuel production process without special preparatory procedures. This results from the fact that these waste types include elements such as worn-out fluorescent lamps, batteries, mercurial thermometers, etc., which are thrown into rubbish bins by residents who do not care for waste sorting.
- Waste coming from the car industry and dismantling of no longer used vehicles (e.g. combustible fractions from the shredder) can also be characterized by a higher content of mercury due to electronic and electrical elements which could not be removed from the waste earlier.
- Stabilized and dried sewage sludge fed directly into the cement industry with no addition of other waste streams or being a component of the refuse-derived fuel is characterized by a wide range of the mercury content. This results primarily from inappropriate waste management in households, which is also the case for other streams of municipal waste.

In plants producing RDF's where drying is applied to reduce the fuel content of moisture and to increase the calorific value, the extra effect is a reduction in the mercury content because the higher temperature involves evaporation of volatile mercury compounds.

In order to limit the possibility of mercury contamination of combustible fractions used as a fuel component, the public should be educated about selective waste collection with a special emphasis on appropriate handling of waste containing mercury.

The standards of emissions related to the refuse-derived fuel combustion and co-combustion are more restrictive than those established for the hard coal combustion, which justifies the opinion that the use of refuse-derived fuels in combined heat and power plants and in cement plants is more friendly to the environment.

New, more efficient sorbents may facilitate a reduction in the emissions of mercury resulting from the combustion of refuse-derived fuels [Wdowin et al. 2014].

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Zawartość rtęci w paliwach z odpadów

Streszczenie: W artykule przedstawiono wyniki badań zawartości rtęci w paliwach z odpadów różnego pochodzenia. Uwzględniono zagadnienia prawne i techniczne związane z ograniczaniem przedostawania się rtęci do środowiska w aspekcie paliw z odpadów wykorzystywanych w cementowniach. W pracy przedstawiono źródła zanieczyszczeń rtęcią odpadów zwracając uwagę na znaczenie selektywnej zbiórki i konieczność edukacji społeczeństwa w tym zakresie. Analiza przebiega według własnej procedury badawczej przy pomocy analizatora rtęci MA-2 firmy Nippon Instruments Corperation. Analizator MA-2 jest przeznaczony do mierzenia zawartości rtęci w próbkach ciekłych, stałych i gazowych, bez konieczności uprzedniej mineralizacji próbek. Granica oznaczania wynosi 0,005 ng Hg. Gazem nośnym jest oczyszczone, suche powietrze. Urządzenie składa się z analizatora rtęci oraz komputera osobistego. Średnia zawartość rtęci w badanych paliwach w zależności od ich pochodzenia: balast z selektywnej zbiórki odpadów, pozostałość po sortowaniu odpadów komunalnych zmieszanych, odpady wielkogabarytowe, odpady z przemysłu samochodowego, osady ściekowe była w zakresie 0,1–1,15 ppm (s.m.). Zaprezentowano wyniki badań zawartości rtęci w paliwach z odpadów, które charakteryzowały się dużą zmiennością tego parametru w zależności od pochodzenia frakcji palnej odpadów i ewentualnego kontaktu z nimi odpadów zawierających rtęć. np. w przypadku odpadów komunalnych zmieszanych i wielkogabarytowych można zauważyć dużo większe wahania tego parametru. W skrajnych przypadkach dyskwalifikuje to te odpady do podania do produkcji paliwa bez specjalnych zabiegów przygotowawczych. Wiąże się to z tym, że do tych odpadów trafiają elementy zawierające rtęć takie jak zużyte świetlówki, baterie, termometry rtęciowe itp., które mieszkańcy niesegregujący odpadów umieszczają w pojemnikach na odpady.