Monitoring of raw materials resources from end-of life vehicles

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Abstract: In this paper work discussed the evaluation of the composition of the waste In terms of their use as an energy source, the results of sampling fraction of light coming from the shredder of ZŁOMPOL in Tarczyn. It was found that waste from end of life vehicles can be a significant source of energy. In particular fractions containing polymer materials with a high energy value. The problem is the significant level of pollution – waste will contain, among other heavy metal.

Keywords: recycling, waste, monitoring, energy, end-of life vehicles

1. Introduction

Waste qualifies as source of energy for both heating and in the power industry. This applies to both municipal waste, biomass, industrial and special waste. Usefulness of waste to energy used depends on the type, homogeneity and thermal properties. The thermal treatment of waste management and reduction of post-consumer materials from: household, industrial, municipal from end-of life vehicles, but also a threat because of the complexity and the large heterogeneity of waste (in the case of incorrect preparation and plant protection) resulting from the introduction into the atmosphere large quantities of gas, often toxic, dangerous to humans and the environment.

The main aspect of the design of cogeneration and decentralized energy production system is the creation of instruments to generate and control the monotonously of waste stream, as well as analyzing and correcting assumptions methods that guarantee the stability of the system.

The aim of this study was to develop guidelines for the design of power plant fuel processing raw materials in vehicle disassembly stations, poviat/communal center fuel processing of raw materials, other processing plants of waste from end-of life vehicles. For the purpose of this work was to demonstrate the environmental consulting the actual available, possible to obtain energy potential from end-of life vehicles.

2. Raw materials analysis of light fraction

The study involved a sample of the light fraction received from fraying at ZŁOMPOL in Tarczyn. Analysis was performed of: weight, quantitative, chemical and spectroscopic composition obtained structures.

Spectral analysis was performed, which was to determine the the light fraction pollution from fraying. The study contains the following matching spectral lines in left and right-handed polarization on the following frequencies: 1562÷1810 MHz sample prepared from the waste light fraction. Figure 1 shows the percentage of the disclosed and identified materials related to the mass of the sample. Figure 2 shows the quantitative contribution of each structure in the sample.

The most commonly used IR technique is IR absorption spectroscopy, used to receive the rotational and vibrational spectra. Infrared radiation (IR) spectroscopy allows for the analysis of both the structure of the molecules and their interactions with the environment [1].

The electromagnetic radiation from the IR range has a frequency close to the natural frequency of the particles. Passing through the sample of tested substance, radiation is selectively absorbed by increasing the amplitude of vibration in the molecules (or crystals) of the substance. In the analysis of these bands for polyatomic systems use the concept of normal vibration, treating each band as a result of the excitation of one or more normal vibrations. Depends on the symmetry of the molecule that normal vibrations are reflected in the absorption spectrum in the infrared range. Infrared absorption accompanied by changes in vibrational energy of molecules. Because energy is quantized, the radiation is absorbed only by certain specific energies characteristic vibrations of functional performing groups. The condition of the radiation absorption (or the possibility of vibration excitation radiation) is the dipole moment of the molecule variability during the vibrations. The IR spectrum is dominated by the absorption bands associated with the fundamental vibration tones molecules. It is possible to register above-tones and combinatorial and differential tones (simultaneous move in two or more oscillators), but they are much weaker.

In modern cameras used a faster method based on asample X-ray beam of radiation from the test range IR (continuous spectrum). After passing the beam through the sample of is brought to its interference with the beam from the same source, but has not passed through the sample of and the spectrum is interpolated using the Fourier transform of the spectrum recorded interference pattern [2].

Z obtained from ZŁOMPOL - light fraction of the material taken three equal, which one of the samples weight. Preliminary evaluation allowed us to determine the color: dark brown, hue: russet, pH: 5.43 acid, fragrance: intense fragrance oil, water content of 3.3 %, the volume light fraction 1 kg as shown in table 1:

Tab. 1. Characteristics of the light fraction sample
Tab. 1. Charakterystyka próbki frakcji lekkiej

	A [mm]	B [mm]	H [mm]	volume [mm^3]
overwhelmed	100	100	64	640 000
after compression	40	30	21	25 200

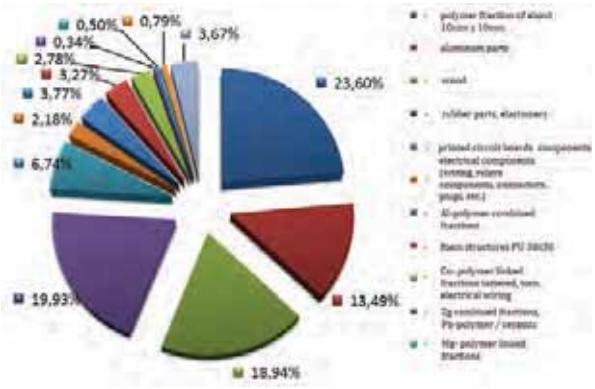

Fig. 1. Percentage structural composition of light fraction after shredding
Rys. 1. Procentowy skład strukturalny frakcji lekkiej po strzępieniu

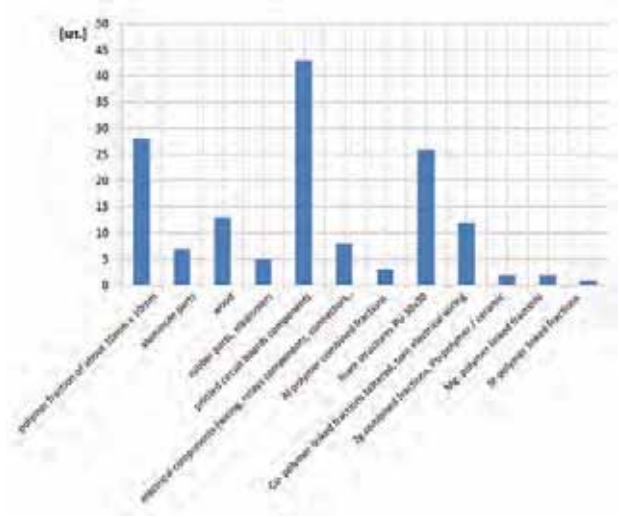

Fig. 2. Quantitative composition of the light fraction after shredding
Rys. 2. Ilościowy skład frakcji lekkiej po strzępieniu

The material studied derivatives were found: alkylene glycol ethers, polypropylene glycols, polycyclic aromatic hydrocarbons, and including benzopyrene, calcium, magnesium, calcium sulfonate, phosphorothioate, dithiophosphates zinc phenolates sulphurised, heavy metals such as: lead, zinc, copper, nickel, cadmium, chromium, manganese, lacquer, resins, pyrene, mercaptans, paraffin. The heavy metal content in the 1 kg reliable sample of the light fraction was estimated at 20 mg÷420 mg.

Based on the composition of analyzes showed that reported pollution comes from oxidized residues, used brake fluids and lubricants in particular oil worked: gear, lubricants, residual gasoline, diesel fuel.

Research work done has shown a wide variety of composition of light fraction. Important for the further use is that pollution, petroleum derivatives, esters and alcohols, as well as high mechanical degradation (as a result of processing) also structural (which is a consequence of the simultaneous action of various corrosive chemicals and UV radiation).

Plastics are the materials with which we are increasingly dealing with. For example, it should be mentioned that, in the past decade, global production of plastics has increased by 62 %, while steel production decreased by 21 %. Post-consumer waste management (regardless of type) is becoming more of a problem.

Recovery of raw materials or energy inherent in the used products, it is still a marginal phenomenon – especially in our country. Landfills the municipal landfills are filled with waste materials, but also in a vast number of polymeric materials [3].

In order to utilize waste plastics technology can be used for energy recovery incineration, pyrolysis – reconstruction of the raw chemical, or mechanical recycling consists in re-processing waste plastics using the usual methods. Taking into account the specific nature of macromolecular compounds, the resulting implications for performance and durability of plastics in operating conditions, as well as the necessary guarantees and methods of modifying polymer waste can allow better use of their material value.

Polymer fractions were analyzed using a spectral analyzer IR – the percentage of possible characteristics of the polymeric material to obtain light fraction of the process shown in fig. 3.

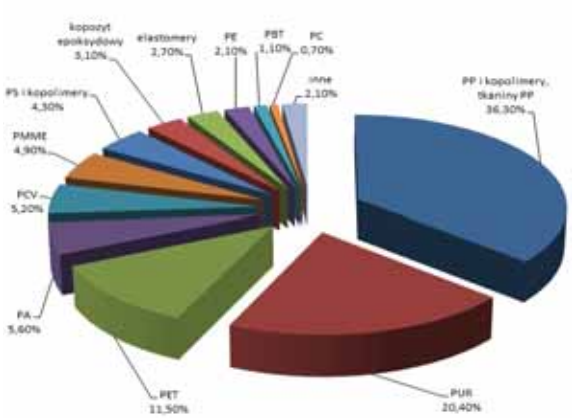

Fig. 3. Percentage reported types of plastics in light fraction from shredding
Rys. 3. Procentowy udział wykazanych rodzajów tworzyw sztucznych w frakcji lekkiej po strzępieniu

The polymers have a high heating value greater than carbon and fuel oils the combustion of the energy point of view it would be preferable, but during combustion of toxic substances (such as hydrogen fluoride, sulfur dioxide). In Figure 4 shows the comparison of fuel content of polymer materials in combination with traditional fuels.

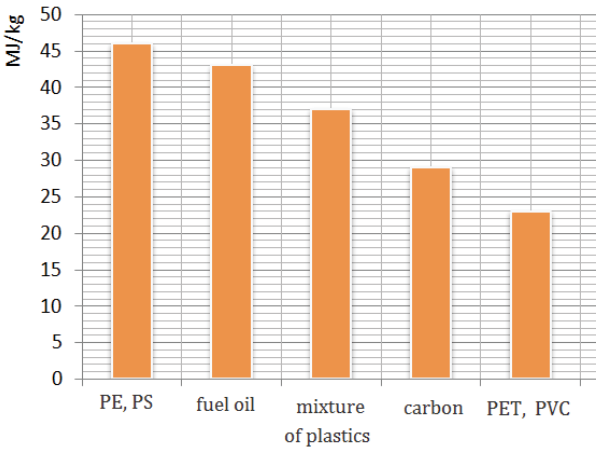

Fig. 4. Statement of calorific values of various materials
Rys. 4. Zestawienie wartości opałowych różnych materiałów

Electrical and electronic scrap is a mixture of different metals and alloys, mainly steel, aluminum, copper and non-metallic components such as plastics, ceramics, glass, rubber, paper, ebonite, wood. Components of scrap metals and non-metals, i.e. are connected by mechanical means (by screws, rivets) or thermal (by soldering, welding, gluing). Among the dominant position in metal steel is about 50 %, while aluminum is in the range 10 to 30 % copper and copper alloys 515.

Electrical and electronic scrap, because of their diversity in size and composition of the complex is one of the most difficult to process scrap. Line of mechanical processing of electronic and electrical scrap shall consist of [10] the basic unit: shredders, magnetic separator, the air separation sieve, separator chamber, drum screen or alternatively electrodynamic separator.

The magnetic separator magnetic components are removed. In the separator chamber – the initial separation of the air is light and non-metallic impurities division of light and heavy fraction. Light fraction is treated as waste. Purified from the particulate material of the light is directed to an air separator – rotation. The coarse sieve fraction is difficult, and the residue derived airstream created light fraction. Fine material passing through the sieve drum creates a small heavy fraction, the residue on the sieve of coarse fraction. Shredder dust the air separators are directed to the dust bag.

The fraction of thick heavy grit than 15, 20 or 30 mm (determined by the type in the screen), it consists mainly of thick pieces of aluminum and copper and its alloys, as well as non-magnetic steel. In this fraction can also be found the alloys of nickel and zinc. The average content of metals in this fraction is about 95 %, the remainder being non-metallic. Heavy fine fraction of grain less than 15, 20 or 30 mm, it consists mainly of small pieces of copper and copper alloys, aluminum and zinc. Metallicity this fraction is about 90 %. The main component of light fraction are metalloids (over 50 %). Depending on the nature of the processed scrap metal components are aluminum the copper in the form of wires of a diameter of approximately 0.1 mm. The fraction containing 10 % of the metal to is treated as waste.

Studies of processing electronic and electrical scrap shredding and separation by gravity and fusion have shown the possibility of obtaining quality alloys. In the case of penetration of light this fraction in which the main ingredient is aluminum alloy can be obtained A6 and got the standard AK 64 (stop AlSi5Cu by the European Standards EN 1676). In the case of granulation, in some parts of the high content of silicon and magnesium granules can be melted together, which will permit a full alloy grade 64th AK. Alloys from melting this fraction obtained due to the high content of lead and tin, especially can not be used directly for the preparation of standardized copper alloys. They can be used as an additive in the manufacture of brass (eg lead) or the copper metallurgy processed in the converter. A characteristic feature is the presence of electronic waste in the precious metals like silver (from a few to tens of grams in 1 ton of scrap metal) and gold (in the range from a few to tens of grams per 1 ton scrap). Precious metals are present as coatings on components (silver) or the connector elements (silver and gold), in the form of pins (silver, gold, palladium, rhodium, platinum) or minor constituents of the electronic components mounted on printed circuit boards, such as transistors, memory chips.

3. Conclusion

It was found that waste from end-of life vehicles can be a significant source of energy, in particular fractions containing polymeric materials with a high energy value. The problem is the significant level of pollution – waste will contain, among other heavy metals.

Bibliography

1. Praca zbiorowa pod redakcją Schroedera G., *Syntetyczne receptory molekularne, Strategie syntezy. Metody badawcze*, Betagraf P.U.H., Poznań 2007.
2. Zieliński W., Rajca A., *Metody spektroskopowe i ich zastosowanie do identyfikacji związków organicznych*, WNT, Warszawa 2000.
3. Żach P., *Plastic raw materials from end-of life vehicles*, „Polish Journal of Environmental Studies", Vol. 38, 2/2012, 151–156.

Monitorowanie zasobów energetycznych z pojazdów wycofanych z eksploatacji

Streszczenie: W pracy omówiono ocenę składu odpadów pod kątem możliwości ich wykorzystania jako źródła energii, przed-

stawiono wyniki badań próbek frakcji lekkiej pochodzącej z strzępiarki firmy ZŁOMPOL w Tarczynie. Stwierdzono, że odpady pochodzące z pojazdów wycofanych z eksploatacji mogą być znaczącym źródłem energii, w szczególności frakcje zawierające materiały polimerowe o dużej wartości energetycznej. Problemem jest znaczny poziom zanieczyszczenia – odpady te zawierają między innymi metale ciężkie.

Słowa kluczowe: recykling, odpady, monitoring, energia, pojazdy wycofane z eksploatacji

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