ANALYSIS OF ENERGY SAVING CHOICE PREPARATION OF MATERIAL RECYCLING TECHNOLOGY ELV-A

ANALIZA UŠTEDE ENERGIJE IZBOROM DOBIJANJA MATERIJALA TEHNOLOGIJAMA RECIKLAZE ELV-A

**Dragiša TOLMAČ¹⁾, Jasna TOLMAČ¹⁾, Slavica PRVULOVIĆ¹⁾,
Milan PAVLOVIĆ²⁾, Hosam Bayoumi HAMUDA³⁾**

¹⁾ Tehnički fakultet „Mihajlo Pupin“ Univerziteta u Novom Sadu, Zrenjanin;

²⁾ FIMEK, Novi Sad,

³⁾ Faculty of Light industry and Environmental Protection
Engineering Budapest, Hungary
dragisatolmac@gmail.com

Recycling of cars includes a variety of procedures, which allow obtaining products from waste materials (metals, plastics, rubber, glass), suitable for the production of new material goods. In the paper the analysis of the recycling of motor vehicles. Motor vehicle recycling industry contributes to sustainability, environmental protection and energy saving. Using recycled materials saves energy and natural resources. Recycling creates less air and water pollution than primary production of raw materials. Recycling saves storage space, create new jobs in companies engaged in the collection, production and distribution of raw materials.

Keywords: recycling, motor vehicles, energy saving

Reciklaža automobila podrazumeva različite procedure koje omogućavaju dobijanje proizvoda jednorodnih materijala (metali, plastika, guma, staklo), pogodna za proizvodnju novih materijalnih dobara. U radu je analiza reciklaže motornih vozila. Industrijska reciklaža vozila doprinosi održivosti i zaštiti životne sredine i uštedi energije. Korišćenjem recikliranih materijala štedi se energiju i prirodni resursi. Reciklaža troši manje vazduha i vode od primarne proizvodnje sirovina. Reciklaža štedi prostor za skladištenje, stvara nova radna mesta u preduzećima koja se bave sakupljanjem, proizvodnjom i distribucijom sirovina.

Cljučne reči: reciklaža, motorna vozila, ušteda energije

1 Introduction

To ensure the successful recycling of motor vehicles is necessary to create an appropriate legal framework and basic infrastructural requirements, which undoubtedly contributed to its development through attracting investments and building technology resources in accordance with the regulations. Also, the introduction of system solutions in the field of automobile recycling contributes to the renewal of the fleet and the consequent reduction of pollutant emissions, traffic safety and saving energetic and raw material resources (Bian et al., 2010; Aleksic et al., 2011). With the start of mass production of cars and waste from the car, which ended his life, the idea emerged that certain parts of such cars can be re-used (as spares). However, the number of these parts are so small that they appeared large dump cars. These landfills affect the environment, and on the other hand represent a large amount of raw materials that could certain technological processing be re-used for different purposes. Thus, in recent years in developed countries (the U.S., Japan, etc.), There are large corporations that take on the responsibility that this job entails. One of the major contributions of this new industry is to reduce environmental pollution. On the other hand, recycling of cars has been hiring large numbers of workers. These problems occur in all parts of the world so that in all countries a need for companies to deal with the recycling of old cars (Trumic et al., 2008; Puric et al., 2011; Milic and Jovanovic, 2011).

2 An overview of existing literature

Recycling of used motor vehicles (ELV) in high-income countries is very successful, especially after the introduction of the shredder in the recycling process of used cars. The rate of recycling in developed countries more than 90% of the used motor vehicles. ELV Recycling helps protect the environment (Hempfl, 2010; Jovanovic et al., 2008). ELV recycling reduces the minerals from natural

sources and generates a source of raw materials for the production of new products derived from recycled materials (prawns, et al., 2005; Tadic et al., 2010). Removing environmentally harmful components and materials, specialty oils, brake fluid, antifreeze, air bags, mercury, freon and similar substances require special treatment and expertise in areas such waste dismantling. In Germany, Centers for dismantling vehicles covering a circle with a radius of 50 kilometers. In Serbia there are about 1.4 million passenger cars and light commercial vehicles. The estimated number of annual waste produced by 120.000 cars a year, which means that a larger number of equipped recycling operators. (Junbeum et al., 2007; Medic, 2011). Recycling of used motor vehicles in the world, is an efficient process which recycles more than 75% of the cars, along with the rate of used cars collected by 95%. In the United States, is recycled about 11 million units, representing a \$ 5 billion of revenue. Automobile Recycling Industry in the United States employs more than 40.000 employees in more than 7.000 companies. In the EU, the number of recycled car reaches 9 million per year, equivalent to 2.2 million tons of waste. As in the U.S., profit mainly by selling used parts and metal. Based on the data (Tolmac et al., 2011a), the number of used cars in the Republic of Serbia, is approximately 100.000 per year. Taking this estimate of the number of used cars, as well as the percentage utilization of certain materials per vehicle, obtained 68.000 tons of ferrous metals, nonferrous metals 6.000 tons, 8.000 tons of plastics and composites, 1.400 tons of fluids, 5.000 tons of rubber, 3.500 tons of glass, 1.000 tonnes of textiles, 1000 battery tons and 6.100 tons of other waste from the used car. In the Republic of Serbia, during the process - recycles 14% of used motor vehicles, because the capacity for industry remains underdeveloped. In the domestic market ELV recycling, demand for secondary raw materials is high, and the level of recycling of 14%, should increase to European levels by 75%. On the basis of the ELV recycling system, we need new investment of over 20 million, in several plants shredder and mobile Balir presses, and increase the efficiency of the (Subaru and Pavlovic 2006; Djordjevic 2004). In Serbia, there are over a million vehicles whose average age is over 10 years. The collection and disposal of waste vehicles mostly depends on supply and demand. Parts with use value is extracted in smaller amount, depending on their age and condition of end. The automobile recycling facilities in the world it is possible to recycle about 80% by weight of the car. The process of recycling cars is complex because of the variety of materials that are part of the car. Middle-class car, on average, consists of 76% metal, plastic 8%, 4% rubber, fluid 6%, 3% glass and other materials 3% (Trumic et al., 2004). Apply two car recycling technologies, which differ in the way of sorting the material that make up the car. The first technology is based on optical (manuelnoj) separation, and other technology uses multiple methods (grinding, gravity separation methods and special). A third possibility is that the whole car pressed in one piece, using mobile Balir presses (Trumic et al., 2008). Further classification of non-metals and non-ferrous metals in fruiting material, achieved through a combination of gravity and special separation methods (electrostatic, optical, etc.), (Trumic, et al., 2009).

3 Results and discussion

Motor vehicle recycling of end of life, according to (Tolmac et al., 2011), is still at an early stage and does not engage a significant number of workers. The research within the project of technological development is defined by a model of integrated and sustainable recycling of motor vehicles at the end of the life cycle (Pavlovic et al., 2011). Thus the set basis for the development of new industries and thus create real conditions for intensive employment in jobs recycling. These tasks include collection and transportation of waste motor vehicles, their removal, selection of components and materials, recovery of components for reuse, crushing shells and chassis, separation of materials, recycling materials, the final disposal of waste.

All this requires a different structure of professional personnel, various recycling technologies and the different composition of objects and corresponding requirements for their location (Bian et al., 2010; Afgan et al., 2009). In Serbia, so far no systematic not address this problem in solving environmental and social, and economic problems when it comes to preserving the natural resources of our country. The project aims to (Pavlovic et al., 2011) to localize potential waste motor vehicles, which can be recycled or used for energy. The most important thing is to determine the scope and structure of the permanent disposal of motor vehicles, especially hazardous waste and suggest measures for their removal or safe storage (Pavlovic, 2009; Pavlovic and Subaru, 2006). The project (Pavlovic et al., 2011), is predicted to form an appropriate centers for the breakdown of used motor vehicles by the respective regions. The significance of the project is big, because it provides savings in the form of

recycled materials. If we know now about 120 thousand cars a year off, and thus are ready for the recycling process, the weight of every vehicle around 1 ton, of which about 70% feromagnetični materials, there are also non-ferrous metals, plastics, rubber; We can not imagine how it is stored resources. Obtaining metals from recycling leads to saving power generation, such as: steel 74%, aluminum 95%, copper 85%, lead 65%. Getting metal recycling reduces water consumption by 40%, reduces water pollution by 76% and air pollution by 86%. In developed countries (35 to 45)% of the new steel is obtained by recycling (Stojanovic et al., 2004). Recycling is the future to solve the problem of waste motor vehicles, in terms of sustainable development. A clear example that proves the previous statement is given in Table 1 (Tolmac et al., 2011b; Trumic et al., 2008):

Table 1. Saving energy by using recycled materials

Materials	(%)
Copper	85
Lead	65
Zinc	60
Aluminum	95
Iron and steel	74
Magnesium	98
Titanium	58
Paper	64
Plastic	80

As can be seen from Table 1, the energy savings by using recycled materials is very important. The investment costs for the construction of waste treatment plants and metal production only (16 to 20)% of the cost to build a plant for processing the raw materials - minerals. In addition, manufacturing technologies based on the processing of secondary metals are much easier and more acceptable for the environment as the example of iron and steel clearly seen in Table 2.

Table 2. The benefits of using iron and steel from waste materials

Benefits	(%)
Energy savings	74
Saving material from ore	90
Reducing air pollution	86
Reduction of water consumption	40
The reduction of water pollution	76
Reduction of mining waste (tailings)	97

4 Conclusions

Motor vehicle recycling of end of life, according to the proposed model is based on the principles of sustainable development (Pavlovic et al., 2011). The establishment of this model in Serbia, in addition to environmental and economic effects of providing a high level of employment, which is very important for social policy. Thus, the number of employees in the entire cycle of recycling of motor vehicles at the end of the life cycle ranges from 6.000 to 20.000 employees. Number of employees varies as a function of:

- ELV available number in the current year,
- the degree of recyclability, • the level of motor vehicle dismantling, • available recycling technologies,
- new products from materials provided by ELV.

Since the operators are to be deployed on the territory of Serbia, so that citizens in their old cars can be submitted at the nearest recycling center which will be issued a receipt which can be realized certain benefits when purchasing a new car. In this way, the action will involve all those involved in the recycling of batteries, waste oil, antifreeze, glass, plastic and everything that makes a car, and it is necessary to invest a total of over 20 million Euros (Medic 2011; Kozic and Sudarević 2005; Gareth and Shahin, 2006).

Metals and energy consumption in the world has a great trend. The reserves are rapidly being depleted. Scrap metal is a very important secondary resource, whose collection and return of the reprocessing process significantly reduces the consumption of primary raw materials, extends the life of the reserves and reduce environmental pollution. Re-use of metals from waste and general reuse of other materials has great economic justification.

5 Acknowledgements

The results presented in this paper derive from the work on the project "Sustainable Development of technologies and equipment for the recycling of motor vehicles" under document number TR 35033. This project is funded by the Ministry of Education, Science and Technological Development of Republic of Serbia.

6 References

- [1] Arsovski, S., Milivojevic, J., Grubor, S., Kokic Arsic, A., Tonic, N., The influence of models of integrated and sustainable recycling of motor vehicles at the end of the life cycle of the level of employment in Serbia, Quality, No. 11-12, 2010.
- [2] Afgan, N.H., Hovanov, N., Andre, P.M., Sustainable Management Organization With Example of Passenger Car Sustainability Assessment, International Journal for Quality Research, Vol. 3, 2009, No. 2.
- [3] Aleksić, A., Arsovski, S., Tonić, N., Grubor, S., Resilience of elv dismantling centres, Nacionalna konferencija o kvalitetu – FQ 2011, str.105-111.
- [4] Hempfl, K., The commercialization of recyclable materials and recycling waste in Serbia, USAID, 2010.
- [5] Ilić, I., Recycling and recycling of secondary raw materials of non-ferrous metals, Bor, 2002.
- [6] Kozic, A., Sudarević, D., Access to recycling of motor vehicles, the Association for Quality and Standardization of Serbia, The quality of Festival 2005, 32. National Conference on Quality, Kragujevac, 19-21. May 2005th
- [7] Milivojević, J., Grubor, S., Simon, A., Sustainable integrated system of recycling of motor vehicles during the life cycle, the First National Conference on recycling vehicles 2009th, Eck, 06 November, 2009.
- [8] Junbeum, K., Junghan, B., Braden A., Recycling Systems and Management of End-of-Life Vehicles (ELVs), A Center for Sustainable Engineering Education Module, October 23, 2007.
- [9] Pavlović, M., Tolmač, D., et al., Sustainable development of technologies and equipment for the recycling of motor vehicles, the Ministry of Science and Technology RS. SRO: Technical Faculty "Mihajlo Pupin", Zrenjanin, (2011-2014.), No. Project: 035033rd.
- [10] Pavlović, M., Directions for the Development of Recycling of used cars in Serbia, the Association for the recycling of motor vehicles of Serbia, Belgrade, 2009.
- [11] Pavlović, M., Subaru, N., Ecological logistics, Tehničkifakultet "Mihajlo Pupin", Zrenjanin, 2006.
- [12] Djordjević, M., Kokic, M., Managing the preparation of a feasibility study of recycling of used materials cars, Project Management and Entrepreneurship, Proceedings, p. 72-76, Zlatibor, 9.-12. May 2004.
- [13] Medić, D., Analysis of the economic potential of the used car market in Serbia, Technical Faculty "Mihajlo Pupin", Zrenjanin 2011th
- [14] Krinke, S., Bosdorf Zimmer, B., Goldmann, D., Life Cycle Assessment of End-of-Life Vehicle Treatment, VOLKSWAGEN AG, June 2005.
- [15] Kozic, A., Sudarević, D., Access to the recycling of motor vehicles, FESTIVAL OF QUALITY, May 2005.

- [16] Gareth, C., Shahin, R., Cost models for increased value recovery from End-of-Life Vehicles, The centre for Sustainable Manufacturing And Reuse/recycling Technologies, Loughborough University, Wolfson School of Engineering, United Kingdom, PROCEEDINGS OF LCE 2006.
- [17] Tadić, D., Arsovski, S., Stefanovic, M., Aleksic, A., A Fuzzy AHP and topsis for ELV dismantling selection, International Journal for Quality Research, Vol. 4, 2010, No.2.
- [18] Tolmač, D., Prvulović, S., Dimitrijević, D., Some aspects of recycling cars, I International Conference „ECOLOGY OF URBAN AREAS“ 2011, Proceedings, pp.127-131, ISBN 978-86-7672-145-0, Technical faculty “Mihajlo Pupin“, Zrenjanin, 30. 09. 2011 a.
- [19] Tolmač, D., Prvulović, S., Pavlović, M., Dimitrijević D., Basic elements of recycling tires, I International Conference - Process Technology And Environmental Protection (PTEP 2011), Proceedings, pp.90-95, Technical faculty “Mihajlo Pupin“, Zrenjanin, 7th December 2011 b.
- [20] Trumić, M., Čalić, N., Andrić, Lj., Ignjatović, M., Recycling Technologies and Sustainable Development, XIX Symposium on Mineral Processing, Oplenac, Serbia, 2004, pp. 257-265.
- [21] Trumić, M. Ž., Trumić, M. S., Marković, Z., Separation of ink particles from waste newspaper by deinking flotation, Journal of Mining and Metallurgy, 43A(2007) pp. 33-41.
- [22] Trumić, S. M., Trumić, Ž. M., Bogdanović, G., Marković, Z., Trumić, G., Deinking of recycled pulps using flotation and magnetic process, 12th Conference on Environment and Mineral Processing, VŠB-TU Ostrava, 5-7, June, Czech Republic, (2008), pp. 169-172.
- [23] Stojanović Dejan, Stojanović Dragan, Trumić Milan., Technologies of recycling cars, XII Scientific Symposium on natural resources and environmental protection, EKOIST 2004, Bor Lake, 30 May - 02 June, Serbia (2004), pp. 638 – 641.
- [24] Purić, R., Lazarević, M., Ostojić, G., Marović, B., Stankovski, S., Rfid-based lifecycle product monitoring for insurance purposes, Facta Universitatis (Mechanical Engineering), Vol.9, No 1, 2011, pp. 119 – 126.
- [25] Milić, P., Jovanović, M., The Advanced system for dynamic vehicle routing in the process of waste collection, Facta Universitatis (Mechanical Engineering), Vol.9, No 1, 2011, pp. 127 – 136.