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DISMANTLING OF END LIFE VEHICLES IN POLAND

Summary. In the paper there are presented problems with dismantling of end life vehicles in Poland. The new solutions are website based database environment for gaining information about materials used in vehicles and methods of dismantling. There is a project of small size dismantling station presented in this article.

DEMONTAŻ POJAZDÓW WYCOFANYCH Z EKSPLOATACJI W POLSCE

Streszczenie. W pracy przedstawiono problemy demontażu pojazdów samochodowych w Polsce. Przedstawiono metody komputerowego wspomagania wymiany informacji o częściach, metodach demontażu, rozbiórki pojazdów. W dalszej części przedstawiono założenia projektowe małej stacji demontażu pojazdów.

1. INTRODUCTION

The number of end life cars increased within the last few years. It is connected with the high volume of imported cars that started to be brought into the country after joining the European Community by Poland. Total number of cars introduced to Polish market reaches 1 million including new and used cars imported from other European countries (fig. 1).

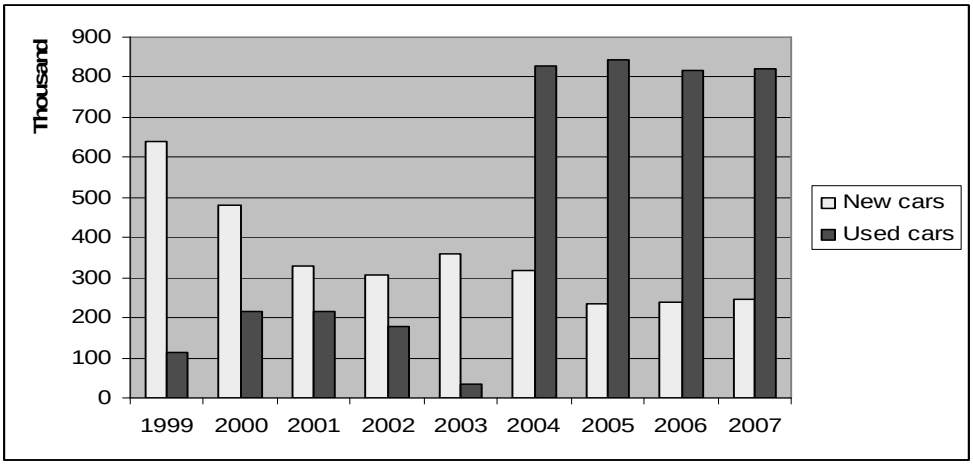

Fig. 1. Total number of cars introduced on the market each year in Poland
Rys. 1. Liczba wprowadzonych pojazdów na rynek polski w latach 1999-2007

Therefore there are new tasks for enterprises and companies dealing with dismantling of end life vehicles and logistics of waste, used parts and materials [7].

2. END LIFE VEHICLES

The task of dismantling end life cars is becoming a serious problem for the environment . The number of vehicles for disassembly increased from 100 000 cars in 1997 to 600 000 in 2004 (tab. 1) [2,3]. Average number of cars introduced per year is about 1 million. This number should be taken into consideration to evaluate volume of disassembled cars for the future. There is still not enough dismantling centers or stations in Poland to provide it in a more professional way with well organized logistics of waste materials.

Tab. 1

Number of vehicles intended for dismantling [years/number]

1997	**1999**	**2000**	**2001/2002**	**2003/2004**	**2007/2008**	**2015**
100000	160000	300000	500000	600000*	600000	~1000000**

* - acc to ITS

** - average number of cars introduced on the market – number of dismantled cars should meet the requirements of Directive [1]

The regulations concerned with dismantling vehicles in European Union are presented in table 2 and became compulsory in Poland after entering EU [8]. The Directive impose limitations of re-use and recycle from 2006 on level 85% and after 2015 on a level of 95% of the average mass of a vehicle [1].

Tab. 2

European Union Directives connected with end life vehicles

2000/53/WE	End Life Vehicles Directive
75/442/EWG	Waste Directive
70/156/EWG	Engine Vehicles Directive
91/689/EWG	Dangerous Waste Directive
75/439/EWG	Rendering Harmless Used Oil Directive
91/157/EWG	Accumulator and Battery Directive

The Directive obliges transfer of used car to specialized dismantling stations. Also vehicle producers are obliged to pay the expenses of vehicle recycling. The producers are also obliged to design vehicles in the way to re-use parts and materials used to manufacture and provide dismantling presentations and instructions.

3. METHODS OF VEHICLES DISMANTLING

There are several methods of dismantling vehicles. The most effective ones are [4]:

- industrial line,
- work dismantling centres
- work station.

In Poland the most popular is the last one.

The industrial line method is similar to production line. The capacity is high and it is analogical to production in the reverse direction (fig. 2). This process requires fluency of dismantling and high productivity.

Fig. 2. Industrial line method of vehicle dismantling [9]
Rys. 2. Metoda potokowa demontażu pojazdów

Each stand is equipped with special tools and other media. First a vehicle is drained from all fluids (fig. 3). Then all assemblies and parts are moved away and at the end there is a car body press. Sometimes a utilization plant is equipped with a shredder. In that case a chassis is directly transported to the shredder

The advantages of that method are:

- possibility of automation at the disassembly process,
- process control,
- improvement of dismantling process,
- minimizing of indirect costs,
- high productivity.

Fig. 3. Drainage of fluids from the vehicle [9]
Rys. 3. Usuwanie płynów z pojazdu

Disadvantages of that method are:

- high starting cost of the line,
- monotonous operations for employees,
- lowering of operational quality,
- lower level of re-used parts.

That type of method is widely used in Sweden and Germany where the problem of utilization great number of vehicles exists a long time.

Dismantling work centre method - in that method a group of workers dismantle parts and assemblies for regeneration, further use or for recycling (fig. 4). Each type of car assembly is separated and segregated and put to individual container and then it is transported to warehouse or recycling station. Each stand is equipped with car lift with pneumatic tools for disassembly. Further disassembly is made on work benches.

Fig. 4. Work centre dismantling method [9]
Rys. 4. Stanowiskowa metoda demontażu pojazdów

The advantages of that method are:

- lower starting costs,
- flexibility of dismantling for different models of vehicles,
- short disassembly preparation time,
- high level of disassembly and recovered parts and raw materials.

The main disadvantage is lower productivity compared to dismantling line method. In practice there is the combination of both methods that are used.

Stationary method is used in firms with lower technical level. In this method disassembly is executed on one stand in continuous form with simple tools. It requires manual dismantling and different skills of workers. The investment cost is low – there are no sophisticated tools required.

The advantages of that method are:

- fast realization of tasks;
- low cost of operation;

Disadvantages are: low productivity and lower care of natural environment. That type of dismantling is widely used in Poland.

4. EVALUATION OF PARTS AFTER DISASSEMBLY

Disassembling and recycling can be a good source of raw materials. The average composition of raw materials in automobile vehicles is presented in table 3.

Tab. 3

Composition of raw materials in automobile vehicles in [%]

Material	Steel, cast iron	Non ferrous metals	Plastics	Rubber	Glass	Fluids	Other
Manufacturing date: 1980-90	72,0	4,5	7,5	5,5	3,5	5,0	2,0
Manufacturing date: 1991-2000	62,0	5,0	17,0	6,0	3,0	5,5	1,5

The most profitable is regeneration of parts and selling of engine subassemblies (or even entire engines), body and chassis assemblies. All parts that could be used again after refurbishing can be sold directly to other users. All remaining like: chassis or body is kept on storage yards on special racks. Then they are transported to shredders (fig. 5). Typically shredding of one vehicle (with average mass 600 kg) takes 20 seconds. Then different segregation methods are used for selecting material by different physical properties. It is made in pneumatic and magnetic segregation. Some of remainings can be recycled as fuel in cement plants or ironworks.

Fig. 5. Metal shredder [10]
Rys. 5. Strzępiarka samochodowa

In Poland there are about 300 authorized vehicle dismantling plants.

5. VIRTUAL SYSTEMS AIDING VEHICLE DISMANTLING AND RECYCLING

Dismantling process and distribution of used parts can be supported by website supported computer systems. One of the systems supporting used parts sale is ARES [6]. Presently there are several dismantling plants in different places in Poland that are using this system. There is used database that enable publishing in the Internet information about parts available after dismantling.
Other system used worldwide is IDIS - (International Dismantling Information System). The system was created by consortium of 58 automobile vehicle producers from different countries including USA, Korea, Japan and also from Europe (e.g. BMW, DaimlerChrysler, Fiat, Ford, General Motors, Honda, Hyundai, IVECO, Isuzu, Jaguar, Land Rover, MG Rover Group, Mazda, Mitsubishi, Nissan, Renault, Subaru, Suzuki, Toyota, Volkswagen, Volvo) [www.idis2.com].

The aim of the system is to supply with information about construction materials and disassembling methods dismantling companies. The information is available online through IDIS website. The main functions of the system are:

- graphical presentation of individual sub systems applied in vehicles,
- filtering acc. to used materials e.g. polypropylene, ABS, glass,
- editing disassembling instructions.

6. PROJECT OF SMALL SIZE DISMANTLING STATION

6.1. Vehicle disassembly timeline

To create a project of small size dismantling station there should be following assumptions taken. After entering dismantling station a vehicle must proceed through the following steps

- weighting of vehicle;
- initial evaluation of technical state;
- storage;
- drainage;
- dismantling of non metallic parts;
- dismantling of steel and non-ferrous metals parts;
- pressing of body vehicle.

Dismantling productivity depends on synchronization of all operations. Disassembly pace is approximately equal vehicle drainage time:

$$T_T = 84'40''$$

For further calculations it was assumed the time as:

$$T_T = 1h30' \ (90')$$

In table 4 there is presented forecast of receipts and costs from one dismantled vehicle taking into consideration components used in manufacturing, prices of raw materials at scrap yard and cost of storage at waste dump [9].

Tab. 4

Receipts and costs for one dismantled vehicle

Materials sale income	800,38
Used parts sale income	496,00
Surcharge from National Environmental Fund NFOŚiGW/ per 1 tone	500,00
Waste dump costs	- 84.30
Total:	**1712,08**

6.2. Break Even Point and risk analysis

Forecast of activity costs for dismantling station was based on the following data:
- plot area 3500 m^2,
- buildings (warehouse, disassembling halls, office),
- sewerage treatment
- basic tools and machines,
- forklifts and other transportation machines,
- computer systems,
- electrical energy cost,
- water.

The staff would be 15 persons including management – 3 persons. The forecast of costs is included in table 5.

Tab. 5

Dismantling costs forecast per year

Total costs	PLN	**853 276**
Fixed costs	PLN	**586 776**
Operational costs	PLN	**266 500**

It is assumed that initial disassembling time of one vehicle would be 2 hours and after getting experience by staff it would be decreased to 1 hour. To estimate BEP the dismantling time was assumed to 1.5hours [9].
The number of dismantled vehicles for one shift (2300h) would be 1533 per year. Operational costs per one vehicle would be:

$$266\ 500 : 1533 = 173{,}84 \text{ PLN/vehicle}$$

BEP determines level of dismantled vehicles to cover all activity costs (1) [5].

$$BEP = \frac{K_S}{C_J - K_{JZ}} \tag{1}$$

where: K_S – fixed costs, C_J – unit price, K_{JZ} – individual operational cost

To determine the number of dismantled vehicles when operational profit is equal zero - this index is shown in the formula (2):

$$BEP = \frac{K_{WS}}{P_{D1P} - K_{Z1P}} \tag{2}$$

where: K_{WS} – relative fixe costs, P_{D1P} – receipts from dismantling of one vehicle, K_{Z1P} – operational costs per one vehicle ,BEP = 586 776 / (1462,08 – 173,84) = 456 vehicles

Estimated value of BEP from formula (2), is equal 456 vehicles. It means the safety margin would be: 1533 – 456 = 1077 vehicles.

7. CONCLUSIONS

In the nearest future there should be created new dismantling stations in Poland. It is connected with the growing number of end life vehicles. The stations should comply with EU directives.

The waste logistics of parts and materials obtained from dismantled cars should be supported by database systems supplied by manufacturers of vehicles.

For the assumed small size vehicle dismantling enterprise the number of dismantled vehicles could be 1533 per year with BEP = 456 vehicles.

Location of dismantling stations should be in the vicinity of plants to be able to recycle materials obtained from disassembling.

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