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## **BEST AVAILABLE TECHNOLOGIES IN END-OF-LIFE VEHICLES RECYCLING**

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**ABSTRACT** - Nowadays environmental experts are facing a huge problem about how to handle the tremendous amount of car wrecks. This is a continuously developing area because of its necessity and because of the strict rules of the European Union.

Today the most efficient car wreck recycling solution is the shredder technology followed by residue separation. There are two kinds of technologies for residue utilization: material recovery (e.g. Volkswagen SiCon, MBA Polymers, Delft Univ.) and energy recovery (e.g. pyrolysis). European Union directives expect to increase significantly the usage of material recovery instead of energy recovery. The most important aim is to change the present practice by lowering the volume of waste getting into the landfill.

### **INTRODUCTION**

The continuously increasing number of automobiles on the roads in the last two decades resulted in that the handling of this enormous amount of car wrecks causes a big problem for environmental protection nowadays.

(120-130 thousand vehicles per annum becomes car wreck in Hungary lately.)

The main problem is that the aspects of waste management haven't been taken into consideration at the time of manufacturing. These car wrecks cause many difficulties to the waste management experts and companies working in car wreck recycling, because they contain several hazardous components whose recycling is quite complicated and problematic.

### **EUROPEAN UNION'S LEGAL BACKGROUND**

The European Union (EU) also puts high priorities on the question of waste management, and puts even more stress on reaching the highest amount of recycling of these car wrecks that is possible.

In September 2000, the EU adopted Directive 2000/53/EC, the so-called ELV-Directive on end-of-life vehicles. First priority of this is the prevention of waste from vehicles and reuse, recycling, and other forms of recovery of end-of-life vehicles and their components to reduce the disposal of waste.

Until the 1st January 2006, for all end-of-life vehicles the reuse and recovery had to be increased to a minimum of 85% by an average weight per vehicle and year, and within the same time limit the reuse and recycling had to be increased to a minimum of 80% by an average weight per vehicle and year. Up to the year 2015 these measures have to reach 95% and 85% per vehicle and year. (2)

## CAR WRECKS' MATERIAL COMPOUND

The current average compound of vehicles:

Iron and steel	Aluminium	Lead, Zinc, Copper	Plastics	Rubber	Glass	Other*
63%	8%	3%	10%	5%	3%	8%

\*mostly it consists of lubricants, hydraulic fluids, coolants and fluids amongst which there are several hazardous wastes

Table 1: The average material compound of vehicles (3)

Ratios that can be seen on Table 1. are related to the wreck compositions too, that has high volume/mass ratio and contains several hazardous and other waste components.

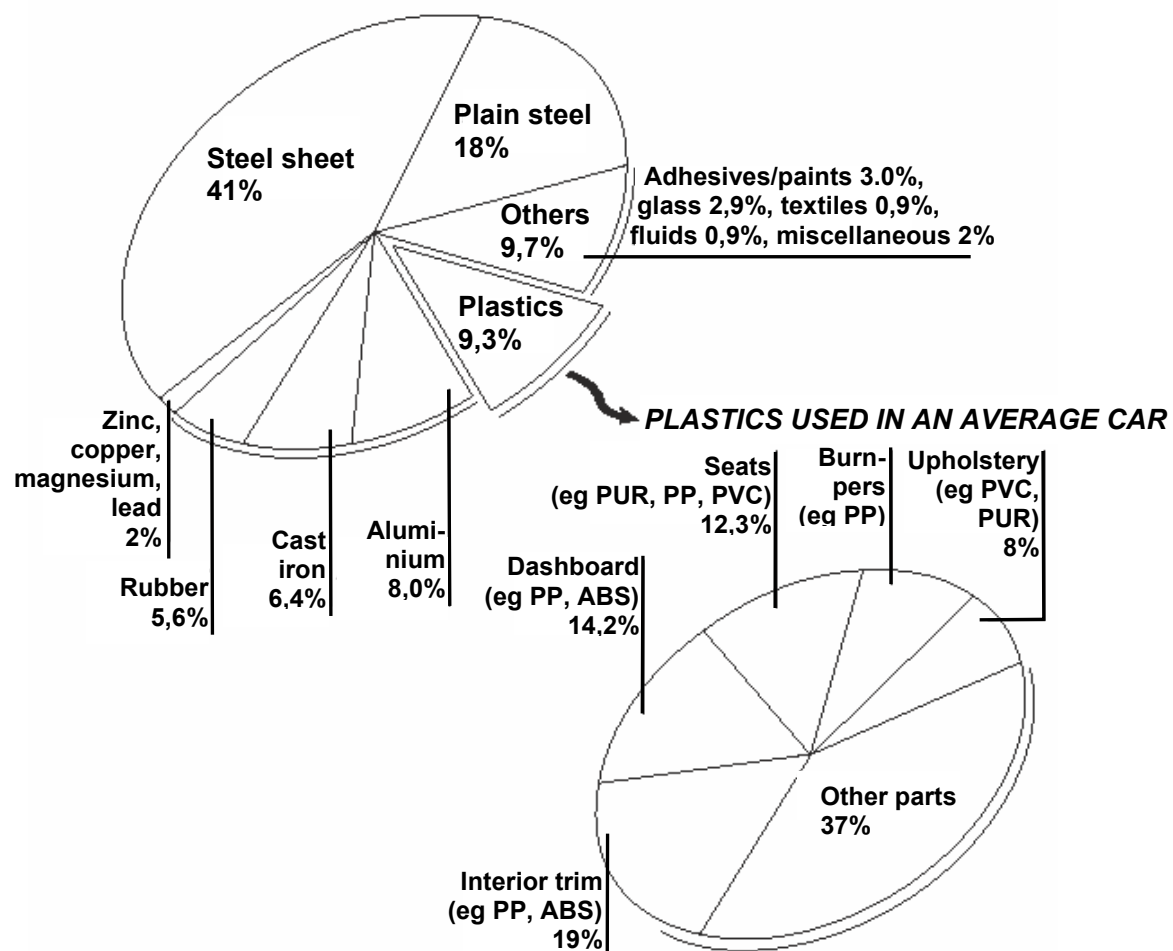


Figure 1: Material used in European Union car production (1998) (4)

Generally car wrecks contain the following material compounds (as you can see on Figure 1.) The metal content: steel sheet, plain steel, cast iron and aluminium gives the biggest part of the car, but plastic content is significant as well with 9,3%, the rubber with 5,6% and the others, that are e.g. glass, textiles and fluids. (4)

The end-of-life vehicles are transported to the dismantlers premises, and they remove the liquids from the wrecks and sell the reusable parts.

Today's most efficient car wreck recycling solution and the mostly used method for separation is the shredder technology that follows the pre-dismantling and liquid removal process.

The automobile shredder is a highly automatised waste-processing machine with a capacity over 100.000 t/y that disintegrates the wrecks. The revolving hammer crushers grind the car wrecks and after that comes the separation of the different materials based on their properties, such as density, magnetic and electric conductivity. (1)

At the entrance of this machine the feed materials are car bodies, mixed scrap, scrap bales, and on the other side arrive the output materials separately: shredded iron, ferrous and non-ferrous metal, and mixed non-metals.

The mixed non-metals fraction includes: rubber, glass and plastics. The name of this fraction is shredder light fraction (SLF) with high calorific value.

This technology could be found on the market, however the issue of shredder light fraction needs increased development because of the strict expectations of environment protection.

The majority of the output materials - being about 76-82% of the processed quantity - are considered as utilizable, and the rest non-metal (SLF) 18-22% means the problematical part.

The car industry nowadays uses 133 kg plastic material per car on the average that means 10,6% of the weight of car. This resulted a total of 2,8 million tons of plastic consumption in the European automotive industry. (5)

The shredder companies has to dispose the rough waste fraction at its own landfill, because there is a lack in burning capacities in Hungary. However it can be stated that it is not a good and acceptable practice because in the long run the aim is to recover as much valuable secondary materials as possible.

The problem is that material recovery from plastic and rubber is non-efficient  
- due to the lack of recirculation stimulating economical and legal background  
- due to the market's dismissive standpoint for secondary materials  
and not enough burning capacity for energy recovery on its own.

An other problem is that if you want to use energy recovery only, the burning capacity is not enough.

The middle-term solution for this problem can be cement kiln burning with fume purificator or an other solution is when the leftover goes to monodeponies.

However the final goal is to decrease the amount of landfill materials. (1)

## TECHNOLOGIES, DEVELOPMENT TRENDS

The 20% shredder light fraction that can not be dismantled further or reused is carried to special landfills built for this kind of waste material storage and called as monodeponies.

This waste material has high percentage of plastics that have high volume/mass ratio and very slow degrading time. That is why it is very important to find a solution for this problem, that decreases efficiently the amount of materials taking to landfills.

There are two kinds of technologies for residue utilization: material recovery (e.g. Volkswagen-SiCon technology, MBA Polymers' technology, Delft University's technology, etc) and energy recovery (e.g. burning, pyrolysis).

European Union directives expect to increase significantly the usage of material recovery instead of energy recovery. The most significant examples of energy recovery is burning and pyrolysis. Material recovery technology needs increased development because of the strict expectations of environment protection because of expensive procedure.

The most important aim is to change the present practice by lowering the volume of waste getting into the landfill.

### Initiatives and already realized new technologies for the material recovery

#### Volkswagen-SiCon technology

In 1999 Volkswagen (VW) developed a new technology in cooperation with SiCon GmbH for the problematic fraction utilization and recovery.

The Volkswagen-SiCon technology uses several already proven preparatory steps, and recovers reusable materials from shredder residue, based on purely mechanical separation. These valuable recovered materials are reused by other raw material utilization processes substituting primary materials. Therefore this technology assists to protect natural raw material sources, that's why this process has already won three environmental awards.

The VW-SiCon technology can reach a 95-96% utilization ratio in car wreck recovery that means an excellent result. This means an economically attractive alternative beside the ecological one, because of the increasing price of raw materials for the secondary raw materials' users.

End product of the process can be used perfectly for filtering clarifier sludge in water purification plants or smelter heating granulate. (6)

Figure 2 illustrates the processes of the above mentioned technology.

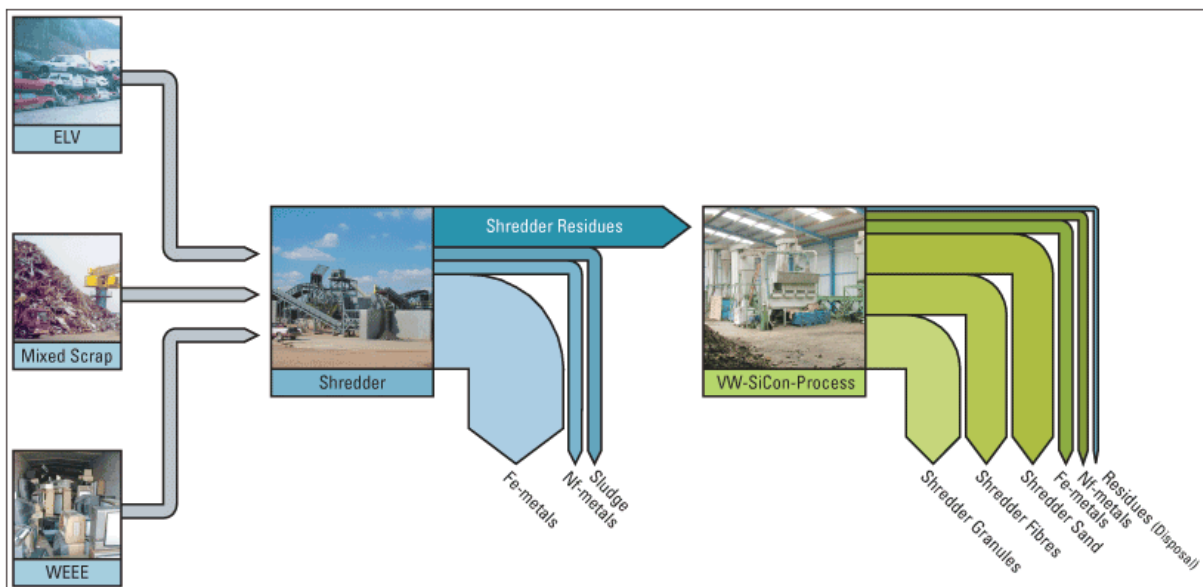


Figure 2: The process of Volkswagen-SiCon technology (6)

#### MBA Polymers - Müller-Guttenbrunn technology (Amstetten, Austria)

MBA Polymers also developed a technology for car wreck recycling.

The first half of 2006 was the start of the MBA Polymers Inc. (California) and Müller-Guttenbrunn GmbH (Amstetten) joint venture. This was the best recycling plant that time. Novelty of the plant in Austria (Kematen, Amstetten) is the entirely automated separator that separates plastic waste from car wreck and produces valuable plastic granulates.

„Magnetic Sorting and Ultrasound Sensor Technologies for Production of High Purity Secondary Polyolefins from Waste” project – FP7.

The complex technology, called „Magnetic Sorting and Ultrasound Sensor Technologies for Production of High Purity Secondary Polyolefins from Waste” is going to be realized by an international consortium coordinated by Delft University of Technology. This is supported by the European Union’s The Seventh Framework Programme for research and technological development (FP7) announced for 2007-2013.

This project’s aim is to recover high purity polyolefins - polyethylene and polypropylene - from the mixed material of shredder light fraction that is deposited nowadays in landfills. To be able to separate these products they develop the BAT (Best Available Technology) separator technology applying magnetic sorting and ultrasound sensor technologies. These high purity products are reused in the car manufacturing industry.

### Different types of energy recovery

There exist different types of practice for handling shredder light fraction.

- After pre-separation it is transported to cement factories and is burnt.
- Pyrolysis technology also can be used. In the course of this pyrolysing process new products are produced that can be sold.

### Burning

The cement factory takes over a certain amount of these wastes, but only those that has high purity. That is because it can keep the strictly specified emission limit measures only if the material is almost so pure like it would have been after coming out from the industrial production. So this material isn’t allowed to contain chlorine and PVC.

The hazardous waste burner premises take over all - even the heavily - contaminated wastes as well, but the price for burning it is so high that it is absolutely uneconomical from the aspect of the operator of the shredder.

### Pyrolysis (Cracking)

One of the newer technologies has been deploying for the last few decades that is based on pyrolysis. The pyrolysis is the chemical degradation of organic materials in reactor.

In the course of this process that takes place in a closed system at a high temperature, at low-oxygen or oxygen-free medium, with controlled conditions the input materials can be degraded to their constituents without arising any by-product. Waste is disassembled into materials without by-product that can be used and sold separately.

During the procedure pyrolysis gas, liquid end-product (oil, tar, degradation water containing organic acid), solid end-product (pyrolysis coke) is generated.

The usage of these products:

- Pyrolysis oil:

Recently it seems to be the best solution to utilize the oil that was retrieved from the process of pyrolysis in internal combustion aggregators for generating the so-called ‘green current’, because this subsidized type of energy by the government results the faster return of the investments of the usage of this technology. In connection with this it constitutes the subject of several examinations the wear of the internal combustion engines and their fuel-supplier systems that is caused by the oil retrieved from pyrolysis. It is also examined what are the possibilities to avoid this problem.

In the current state when the oil prices are about 100 dollars per barrel it can be worth to hand on this pyrolysis-oil to the oil-vendor companies and to bring it under the steps of further refinements.

- Pyrolysis gas:

It is also much in demand product the pyrolysis-gas that is used for generating current in gas-turbines or in heating plants.

- Pyrolysis coke:

The coke from pyrolysis is also well marketable in the paint industry as colouring matter or possibly usable in filters.

The pyrolysis plays significant role mostly in the hazardous waste disposal.

Pyrolysis has the following advantages compared to burning:

- Less harmful emission than burning,
- Much higher amount of useful material,
- However its economical benefit strongly depends on the marketability of its final products.

For hiding away the waste-tires there exist several conceptions.

Usually the rubber-grinding and the burning in the cement kilns is used. In the case of the sliced waste-tires oil and soot will be the final product. The former is marketable as fuel, and the latter as an essential fuel of the rubber production.

In the course of the pyrolysis process of rubbers there arise some steel waste amounting about 10% that can be reused in steel smelters without problems. (1)

## SUMMARY

It can be stated that according to the recommendations in the directives of the European Union the material recovery is more preferred than the energy recovery. In addition it supports that even the car raw materials should be reusable and recyclable. Since there does not exist any reliable method for the separation of the material mixture of this problematic fraction known as SLF, it would be highly suggested to make extra efforts to develop such technologies.

In the last few years several studies were made in this subject that underpin that among plastics utilized in vehicles only the material of the bumpers mean such quantity of material that can be reused economically in its ordinary aim – after pre-dismantling.

In the regard of all the other components of the vehicle the demand of the living labour and the separation (after shredding) technology development expenses had made these experimentations uneconomical.

So the only solution remains the energy recovery – at least until the price of raw materials do not increase significantly.

Summarising the goals and recommendations of car wrecks recycling:

Most important development goal is the complex recycling it means that we have to decrease the amount of landfill waste, by choosing the best available separation technology.

We have to endeavor to reach the highest possible ratio of material recovery that is suggested by the European Union. If this is not economical we should use pyrolysis technology from energy recovery field.

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