



WORKBOOK RECYCLING OF MACHINERY AND MATERIALS

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Projekt współfinansowany ze środków Unii Europejskiej w ramach Europejskiego Funduszu Społecznego



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Recycling - an activity which involves repeated processing of substances or materials contained in the waste in the manufacturing process in order to obtain the substance or materials with initial purpose or another one, including also organic recycling except for the energy recovery.

Another definition gives that recycling means secondary processing, which involves the usage of waste, used elements (e.g. parts of the machines) to generate new products e.g. waste paper for the production of paper, used car tyres as the fuel in cement factory.

The recycling system covers the following elements:

- Proper state policy favorable for recycling;
- Proper designing of goods:
 - possible the widest usage of the materials in them suitable for recycling;
 - using uniform materials, which simplifies the disassembly and segregation;
 - connecting different materials in such a manner so that their later separation was as simple as possible;
 - using components which are suitable for the repeated usage without processing or with the minimum treatment;
- Development of technology of waste treatment in order to use it in the largest possible amount;
- The system of marking the waste of the products and their components in the products in order to facilitate the segregation;
- Logistics of sorting, gathering and collecting the used waste;
- Proper preparation of the waste for processing and processing and recycling of waste.

It is worth noticing that the recycling takes place in both ways. On one hand it is forcing the recycling principles already with the manufacturers of goods, on the other hand, creating proper behavior with the consumers as the recycling takes place in both areas: manufacturing goods and later creation of waste from them.

Three types of recycling are differentiated:

- Repeated application – repeated application of the material or product for the same purpose (e.g. tyre retreading, replacement bottles);
- Further application – usage of the waste for the new applications after proper physical, chemical or biological processing (e.g. granulation of the used plastics and tires, where the granulate is used as a filler in building materials);
- Repeated usage – recovery of chemical waste from trash and repeated introduction it into the production (e.g. usage of car wrecks in steel works).



Within the frames of the design classes in the subject of Recycling of machinery and materials, the students in a few stages develop a project of a technological process of recycling of the selected technical facility. The facility can be any device (machine, processing apparatus) or groups of devices which realize similar task.

1. SELECTION OF THE TOPIC OF THE REALIZED PROJECT

The students select the topic of the project from among those proposed by the person conducting the classes. The projects refer to the development of the technological process of recycling of a selected device or a group of devices which realize the same tasks. Below there is an example of topics of the projects realized:

- Project of a technological process of recycling of a mobile phone;
- Project of a technological process of recycling of a vehicle;
- Project of a technological process of a recycling of LCD TV;
- Project of a technological process of recycling of home cooling devices;
- Project of a technological process of a recycling of an electric lawn mower;
- etc.

2. LEGAL ACTS CONNECTED WITH RECYCLING OF A SELECTED TECHNICAL FACILITY (DEVICES, GROUPS OF DEVICES)

The students make the analysis of legal acts connected with the recycling of a selected technical facility (devices, groups of devices). Then, the documents are discussed and in the study the most important fragments are written down (provisions, paragraphs) from the point of view of a manufacturer of a device, user, an entity dealing with recycling or organization of collection of items, e.g. disassembly station of vehicles, a place of receipt used electric and electronic devices, acid-lead batteries withdrawn from exploitation, etc. Exemplary legal acts used during work over the projects realized are: The act on vehicles withdrawn from exploitation, the Act on used electric and electronic equipment, the law on economy of waste and package waste, etc.

Exemplary entries which may be found in the study „Project of a technological process of recycling of a vehicle”:

Obligations of those introducing the vehicles:

Art. 6.

1. An entrepreneur being a manufacturer of the vehicles shall be obliged to:

- 1) limit the application of hazardous substances in the vehicles for preventing the emission of these substances into the environment and facilitating the recycling of the vehicles withdrawn from the exploitation;
- 2) including requirements of disassembly and repeated usage of the equipment items and parts of the vehicles and recycling and renewal of the vehicles withdrawn from exploitation;
- 3) application of materials coming from the recycling for the production of vehicles.



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2. The provisions of it. 1 point 1 and 3 are applied properly to the manufacturers of the equipment and parts of the vehicles.

Art. 9.

1. The entity introducing the vehicles shall be obliged to study the information concerning the disassembly method of a new type of the vehicle within 6 months from introducing it in the country.

Art. 11.1. The entity introducing the vehicle shall be obliged to assure the network for collecting the vehicles, hereinafter referred to as „the network”, covering the territory of the country in such a manner so as to assure for the owner a possibility to give the vehicle withdrawn from exploitation to the collecting point of the vehicles or the disassembly station, located in the distance not larger than 50 km in a straight line from the place of residence or the seat of the vehicle owner, with a reservation of art. 12 it. 1.

Obligations of the owners of the vehicles:

Art. 18.

The owner of the vehicle withdrawn from exploitation may transfer it exclusively to the entrepreneur who conducts the disassembly station or the entrepreneur who conducts the point of collecting vehicles.

Art. 19.

The owner of the vehicle withdrawn from exploitation or the person authorized by him while transferring the vehicle to the entrepreneur conducting the station of disassembly or an entrepreneur conducting the point of collecting vehicles, shall be obliged to:

- 1) show ID or another document which confirms identity;
- 2) registration card of the vehicle or the vehicle card, if it was issued or another document confirming the data contained in the registration card;
- 3) the document confirming the ownership in case of the owner of the car different than the one entered in the registration card.

Obligations of the entrepreneurs conducting disassembly stations:

Art. 21.

An entrepreneur conducting the disassembly station should assure processing of vehicles withdrawn from exploitation with the waste created from them in the way safe for people and the environment.

Art. 23.

1. An entrepreneur conducting the disassembly station shall be obliged to accept each vehicle withdrawn from exploitation, which has the identification features of the car, referred to in art. 66 it. 3a point 1 of the act of 20th of June 1997 – The Traffic Law, with a reservation of it. 7.

2. An entrepreneur conducting disassembly station while accepting the vehicle withdrawn from exploitation may collect the fee from the owner of the vehicle, with a reservation of it. 3 and 6.

3. An entrepreneur conducting the disassembly station does not collect the fee, referred to in it. 2, if the following conditions are jointly met:

- 1) the vehicle is registered in the territory of the country, in accordance with separate provisions;
- 2) the vehicle is withdrawn from exploitation:
 - a) is complete, b) does not contain any other waste, which does not come from a given vehicle.



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4. The complete vehicle is the one which contains all significant elements and its weight is not smaller than 90% of the vehicle mass.
5. In case of accepting the incomplete vehicle from the owner withdrawn from exploitation the fee, referred to in it. 2, may not exceed the level of 10 PLN for 1 kg of the missing mass of the vehicle.
6. An entrepreneur conducting the disassembly station does not collect the fee, referred to in it. 2, while accepting the incomplete vehicles of the Police and the fire protection units.

3. THE TECHNICAL AND MATERIAL CHARACTERISTICS OF THE FACILITY BEING SUBJECT TO RECYCLING

The students discuss and then describe the function fulfilled by a technical facility (a device, a group of devices) its construction with a specification of the most important elements of a device (sub-assemblies, parts). The students make also identification an characteristics of materials intended for the construction of particular elements of the facility. They also analyze a variety of materials used for the construction by different manufacturers of devices. The students should also pay attention to the occurrence of hazardous materials in the construction, e.g. heavy metals. The example of the realization of this part of the project was presented on the figure 1 and in the table 1.

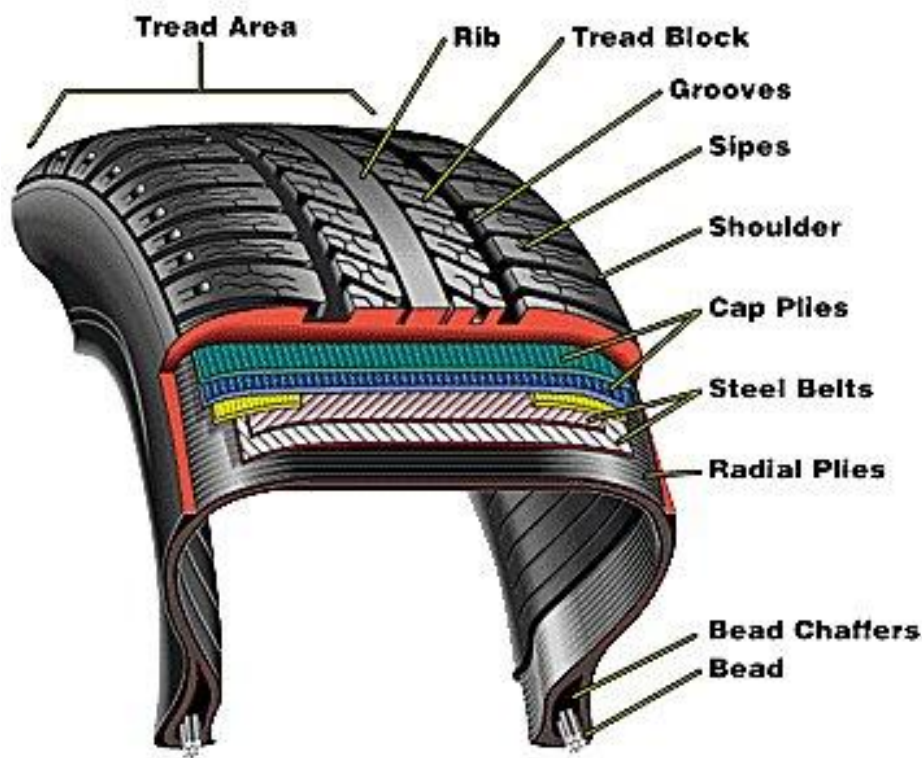


Fig 1. Construction of a tyre. Topic of the realized project:: „Project of a technological process of recycling of car tyres”

Tab. 1. Material composition of tyres in the European Union. The topic of the project realized: „Project of a technological process of recycling of car tyres”

Materials	Tyres of cars	Tyres of trucks and buses
Rubber	47 %	45%
Soot	21,5 %	22%
Steel	16,5 %	25 %
Textile cord	5,5 %	-
Zinc oxygen	1 %	2 %
Sulphur	1 %	1 %
Chemical additions	7,5 %	5 %

4. ANALYSIS OF KNOWLEDGE IN THE SCOPE OF THE EXISTING RECYCLING TECHNOLOGIES OF A TECHNICAL FACILITY (DEVICE, A GROUP OF DEVICES)

The students review the literature in recycling technology of a selected facility (devices, groups of devices) or devices fulfilling the similar function and characterized by a similar construction and materials applied for their construction. They discuss and analyze the existing solutions.

5. SYSTEM OF GATHERING, STORING AND TRANSPORT OF A SELECTED TECHNICAL ENTITY (DEVICES, GROUPS OF DEVICES)

Discussing the problems of organizing the collection, proper storage and securing and transport of the technical entities collected.

6. DISASSEMBLY OF A SELECTED TECHNICAL FACILITY (DEVICES, GROUPS OF DEVICES)

The students analyze possibilities to apply manual or automated disassembly of a selected technical facility in order to separate the elements initially performed from one material or materials with similar characteristics possible to process with the same technology. They pay attention to the occurrence of hazardous materials and the supporting structures for special treatment, e.g. acid-lead batteries. They give technical solutions, necessary tools and devices used for disassembly as well as parameters of automated processes of disassembly.



7. PRODUCT RECYCLING OF A TECHNICAL FACILITY (DEVICES, GROUPS OF DEVICES)

Performed analysis of disassembly technology shows a possibility or the lack of a possibility to realize the product recycling, namely direct repeated usage of parts of the items being in a good technical condition, with a small degree of usage. We distinguish two variants:

- product direct recycling – this is the simplest form of recycling involving disassembly of parts suitable to be mounted in other devices,
- regeneration of parts – restoring usage properties by means of putting regeneration layers (e.g. chromium) which extends the usage period.

This form of recycling requires the outlays in the form of working force for developing a proper technology, using raw minerals. The process covers an initial disassembly, then washing all elements, in the end, regeneration of elements suitable for processing. Minimum strength of the element after regeneration may not be smaller than 80% in relation to the new part. For economic reasons, the regeneration may not be more expensive than producing new parts. Therefore, it is necessary to review and assess technical condition of the elements being regenerated, as on them depends the decision on conducting regeneration, its profitability and quality of the parts obtained in the process.

The students give the elements of the facility possibly fast for product recycling and present technical solutions (devices, tools, diagnostics posts).

8. PROJECT OF A TECHNOLOGICAL PROCESS OF RECYCLING OF A SELECTED TECHNICAL FACILITY (DEVICES, GROUPS OF DEVICES)

The students perform a project of a technological process of a selected facility starting with disassembly by means of next unit operations performed with a device or elements coming from the device until new applications for the obtained materials or their utilization are performed.

For each separated material from the device the students propose one recycling method: material recycling (mechanic), raw mineral recycling (chemical), energetic recycling (combustion with energy recovery).

Material recycling involves processing waste into the product with an utility value. Usually, it is a product with different purpose than initial one which creates a cascade system in which each initial stage has smaller requirements than those posed for the product. The proper selection of a composition allows for processing of secondary materials with huge efficiency with good quality of products. This method is technologically simple if it refers, e.g. to materials with identical chemical structure. The example of a cascade recycling is the usage of materials coming from the poly-propylene bumpers for the construction of heaters, shields of air-conditioning systems. Then the materials from these parts, may be used e.g. for the production of carpets (second generation).



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Raw mineral recycling involves restoring raw minerals used for the production of a given product. The raw minerals may be used again to generate full-value materials. Basic advantage of the method is e.g. a possibility of processing the products without their prior segregation. Whereas, the application of complicated installations, high temperature, pressure, catalysers and strict control of parameters cause limitations in popularization of this group of recycling methods.

Energetic recycling involves partial regaining of energy, used for generation of products, which are on the storage pit (including packaging).

The students develop and present block diagrams containing the names and parameters of the unit operations (example, figure 2).

They describe the task of other operations. They select from available paper sources and internet ones (e.g. paper and electronic catalogues of manufacturers of devices) the devices for the realization of unit operations to present their schemes and technical parameters. They match the selected devices in the apparatus lines and present them in the form of schemes (example, figure 3). The students in the study contain also the operations of internal transport (inter-post).

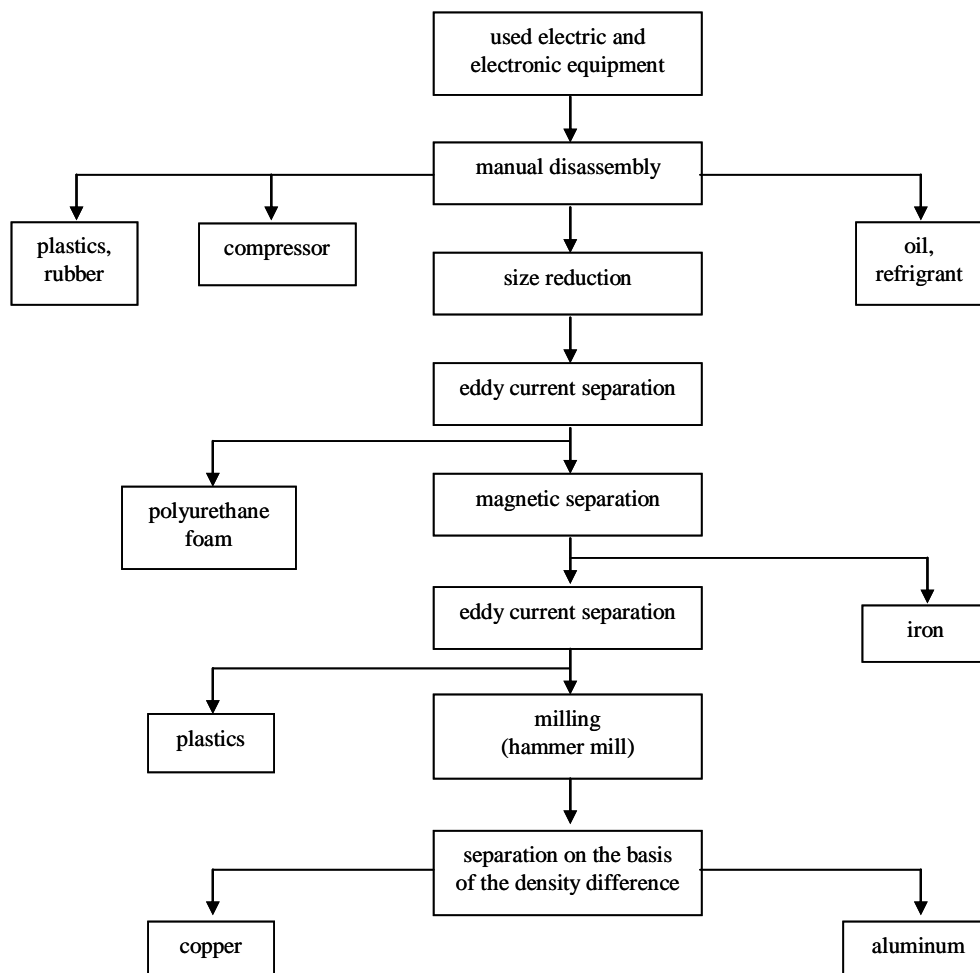


Fig 2. Exemplary block scheme of the process of recycling of cooling devices

Przykład instalacji do recyklingu opon w temperaturze otoczenia

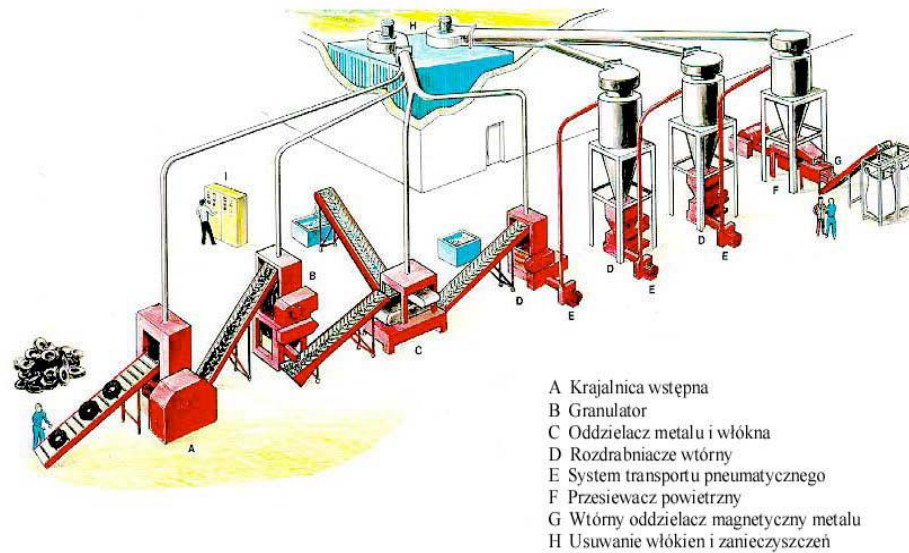


Fig 3. Exemplary scheme of apparatus line: An example of a tire recycling at ambient temperature: A - first cutter, B - granulator, C - metal and fiber separator, D - crusher, E - pneumatic transport system, F - aerial sifter, G - secondary metal magnetic separator, H - removing fibres and dirt.

9. SUMMARY

In the summary, the students analyze and give proposals of more pro-ecological constructions and production technologies of a technical facility. In the analysis they include designing, building, usage and disassembly of technical facilities.