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LIFE CYCLE OF TECHNICAL OBJECTS – ENVIRONMENTAL ANALYSIS

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Summary. An analysis of a full life cycle of technical objects makes it possible to identify defects and locations for the introduction of potential improvements with a view to limiting their impact on the environment. This impact is characterized by means of the so-called environment description of the data of technical objects. The paper concerning the environment-related determination of technical objects was narrowed down to two stages: technical object of use phase and end-of life technical object.

Key words: life cycle of technical objects, end-of life technical objects, reuse, recycling, recovery

INTRODUCTION

Together with the development of the methods used in the determination of the impact of technical objects on the environment [2, 8, 10, 13, 15] in relation to these objects, the concept of the life cycle or the existence cycle was introduced. Such a methodological approach which determines the life cycle is applied to many scientific disciplines [1, 3, 9]. In economic sciences, the existence cycle is specified as the time between the moment a product is launched on the market and the moment it is withdrawn from the market. However, in relation to technical objects, the notion of the life cycle is defined in a manner which is different from the one applied in economy. The existence cycle is not the only issue. The life cycle of living organisms was used, where the following phases are distinguished: the phase of the occurrence, the life phase and the phase of death or decomposition, the result being joining the global circulation of matter. Just like living organisms, technical objects are also subject to regular transformations. Thus, the existence of any object is cyclical in its course. Considering the similarities to living organisms, it is specified as a life cycle [6, 7]. The life cycle of a technical object is presented in Fig. 1, where four phases are distinguished: designing, manufacturing, operation and end-of life with the accompanying processes of waste management through recovering from them elements and materials to be processed again.

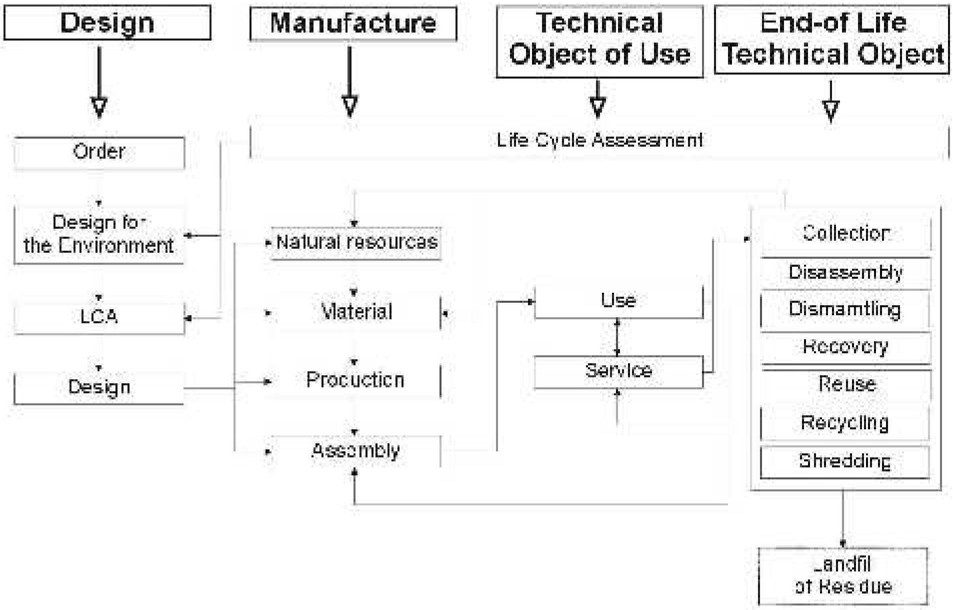


Fig. 1. The life cycle of a technical object

TECHNICAL OBJECT IN USAGE PHASE

The purposes for which a given technical object was designed and manufactured are realized at the operation stage. At this stage, the phases of the use and maintenance are to be distinguished together with the period when a given object is waiting for the use or maintenance. A detrimental influence of technical objects at the operation stage is the result of such phenomena as mechanical and acoustic vibrations as well as electromagnetic and corpuscular radiation [11]. It is also during the realization of the maintenance process of objects that waste is generated in the form of used-up operation liquids and worn-out elements and sets. The stage when the object is waiting for operation or maintenance constitutes a certain hazard to the environment. The sources of environmental impacts on the operation stage partially overlap with contamination sources occurring during the realization of the manufacturing phase while this impact is diversified. When analyzing the impact of energy consumption on the above-mentioned stages in relation to an M_1 [17, 18] category passenger car, the energy consumption at the operation stage is 73.10%. The percentage share of the energy consumption in relation to the analysed car and equipped with a driving unit with the cubic capacity of 1398ccm and an average leaded petrol consumption of 6.55 l per 100km is presented in Fig. 2.

The environmental impacts generated by means of transport at the operation stage need to be divided into two basic groups, i.e. a direct environmental impact and an indirect environmental impact (Fig. 3).

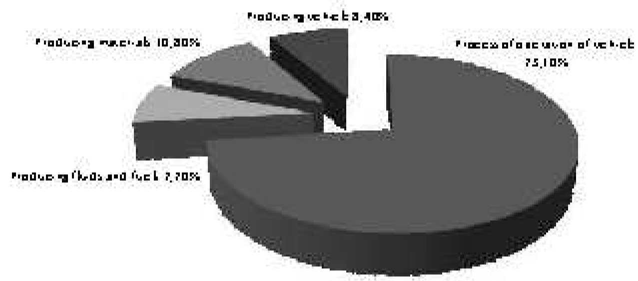


Fig. 2. The waste of energy through a technical object at the stage of the producing and operation

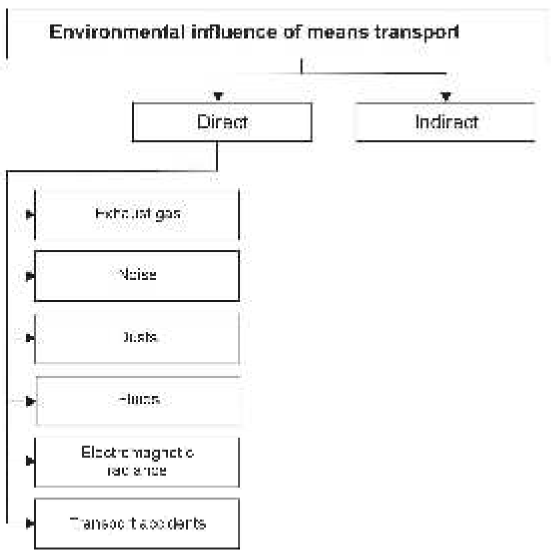


Fig. 3. The environmental impacts generated by means of transport

END-OF LIFE PHASE OF TECHNICAL OBJECT

Any technical object withdrawn from operation is treated as waste which needs to be utilized in a way that is safe and friendly for the human life and health, as well as for the natural environment [4, 16, 19, 20]. This utilization should consist in the maximum use of elements and materials from these objects in operation and industry, a very limited use in energy industry and a sporadic disposal of the remains at a waste dump.

When dealing with waste, we talk about recovery and neutralization [5, 14]. The process of neutralization consists in an environmentally safe utilization of this waste which cannot be reused. The generated waste is subject to the processes of biological, physical or chemical conversions in order to lead them to such a state when it does not pose any threat to the human life and health or the environment. In the case of worn-out technical objects, the process of neutralization cannot be applied as the generated waste can be reused or processed. The process of recovery is to be applied here. The definition included in the legal act concerning waste specifies recovery as any activity which does not pose any hazard to the human life and health or the environment, and which leads to the use of the whole of waste or its part, or to recovery from waste substances, materials or energy which are to be utilized [19]. According to the definition, recovery can be divided into two basic forms, i.e. recycling and recovery of energy (Fig. 4). The recycling process is divided into two basic forms, i.e. product and material recycling. Product recycling consists in the recovery from phased out objects, the elements of which are in good technical condition. The elements recovered in this manner become inexpensive spare parts, which can be successfully used in operation. A repeated use in operation is the application of elements dismounted from those objects which were phased out: for the same purpose for which they were initially designed and manufactured. Product recycling can be divided into direct recycling and regenerations. A direct product recycling is a process which is realized through the process of disassembly, which leads to the recovery of those elements which are fit for a repeated use in operation. A product recycling in the form of regeneration is a process which restores to the worn-out elements such properties which are close to a new product. Regeneration is applicable to expensive and untypical elements and units. A material recycling consists in converting into recycable waste of those elements which cannot be reused in operation, i.e. such elements which were not subject to a product recycling. At the same time, materials recycling constitutes one of the most difficult forms of recycling as regards technical, organizational and economic aspects. Cascade recycling is one of the varieties of materials recycling, whose purpose is to use the material for a different purpose than the previous use, i.e. production of less durable and less important elements. For example, an old polypropylene bumper, once it has been ground, is used as material for the production of heater housings, shields of air conditioning systems as well as ventilation and heating ducts (the so-called first generation). Next, materials from these parts can be used in the production of carpets (the second generation). Raw materials obtained as a result of cascade recycling are also used outside the motor industry, for example, materials obtained from bumpers and battery housings are used for the production of benches on stadiums, barrels, pipes, sound barriers and also household goods [5].

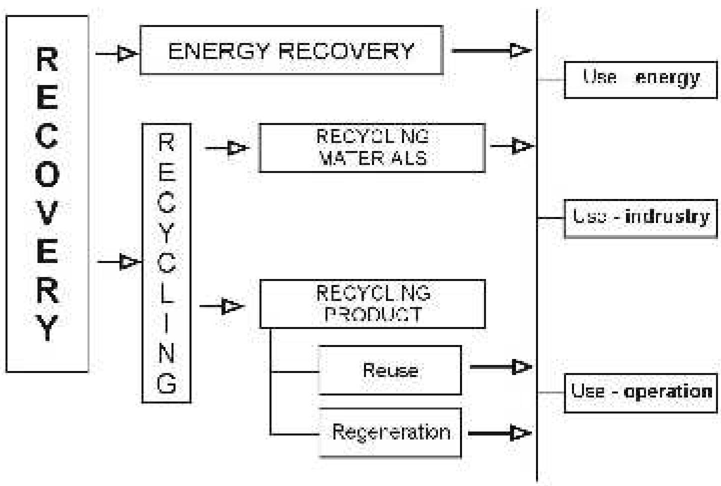
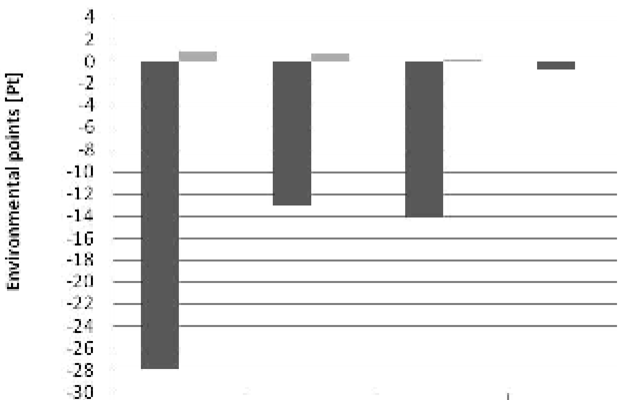


Fig. 4. Forms of recovery

A comparative analysis of the process of recovery and disposal of waste on waste dumps in relation to a phased out SSL driving unit demonstrates that the process of recovery leads to environment-related advantages, while disposal has a negative effect on the environment. The results obtained from recovery and disposal divided into individual groups of materials are presented in Fig. 5.

The largest advantages for the environment on the levels of -14.182Pt and -12.948Pt were obtained after carrying out of the recovery process of scrap from non-ferrous and ferrous metals. At the same time, the recovery of the remaining materials has led to the obtainment of environment-related advantages on the level of 0.781Pt. Recovery of the individual materials from the phased-out driving unit is the source of environment-related advantages on the level of -27.948Pt, while the disposal of these materials as waste on a waste dump has a negative impact on the environment on the level of 0.898Pt. The required condition for such significant environment-related advantages is the correct execution of the process of the recovery of elements and materials from the phased-out driving unit. The correct execution of the recovery process requires an implementation and application of disassembly specified as a process of a decomposition of the object into single elements or subassemblies, whose purpose might be a replacement of a damaged element, recovery of valuable elements and materials from those objects which are to be recycled, or extracting from them such materials which are harmful to the environment [12].



	Engine	Scrap ferrous metals	Scrap non-ferrous metals	Other materials
Recovery	-27,948	-12,985	-14,182	-0,781
Waste storage	0,898	0,698	0,128	0,072

Fig. 5. Levels of interactions generated during recovery and disposal

CONCLUSIONS

The stages as specified in the paper in the life cycle of a technical object make it possible to conduct research for the individual stages and for the full cycle. This dependence was used in the research concerning the impact of individual objects on the natural environment. The cducted experimental tests were narrowed down to the use phase and the end-of life phase. Focusing the tests on those stages which are directly linked to the use of technical objects made it possible to indicate those areas where there are opportunities to obtain environment-related benefits. One of such areas is the optimization of the reuse, recycling and recovery of the elements and materials from a technical object on the use phase.

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CYKL ŻYCIA OBIEKTU TECHNICZNEGO – ANALIZA ŚRODOWISKOWA

Streszczenie. Analiza pełnego cyklu życia obiektów technicznych umożliwia zidentyfikować wady i miejsca wprowadzenia potencjalnych ulepszeń prowadzących do ograniczenia ich wpływu na środowisku. Wpływ ten jest charakteryzowany poprzez tzw. środowiskowe charakteryzowanie danych obiektów technicznych. W pracy środowiskowe określenie obiektów technicznych ograniczono do fazy eksploatacja i wycofanie z eksploatacji.

Słowa kluczowe: cykl życia obiektu technicznego, obiekt techniczny wycofany z eksploatacji, ponowne użycie, recykling, odzysk