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EMS as a basis of sustainable technological process achievement

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ABSTRACT

Purpose: The paper presents main principles of environmental management systems ISO 14001 and EMAS. Thanks to EMS organizations can improve theirs activity especially through environmental modernization introducing to realized technological processes.

Design/methodology/approach: Implementation of EMS provides organizations many benefits: increasing the efficient use of resources; waste reducing; demonstrate a good corporate image; building awareness of environmental concern among employees; gaining a better understanding of the environmental impacts of business activities and increase profit, improving environmental performance.

Findings: In this article structure of ISO 14001 and EMAS were presented. Moreover the analysis and the modernization of the oil filter casings production process were showed.

Research limitations/implications: Both ISO 14001 and EMAS II application all organizational units, especially industrial enterprises. The EMS requirements make possible technological processes continuous improvement especially in environment protection sphere.

Practical implications: Formalized environmental management systems ISO 14001 and EMAS help enterprises in accommodation to the growing requirements of the environment protection prescriptions.

Originality/value: The only one possibility of the environment protection is implementation and continuous improvement of EMS by every organization. It can be achieved through technological processes improvement.

Keywords: Environmental management; Environmental management systems; Technological process; Sustainable technological process

1. Introduction

Union strategic purpose is transformation of Union until 2010 into most dynamic, competitive and knowledge based community in the World. To achieve this, EU tries to more actively involved in development of economic, social and environmental activities. From the environmental point of view, it means necessity of separating environment degradation from economic growth level, introduced sustainable production and consumption rules, resources protection and also sustainable management of these resources [1].

One of the mechanisms which makes possible to achieve this is the environmental management system (EMS) [2].

First conceptions of the environmental management systems were formed in 80th of XX century and they are still developed from this time. Achieving continuous reducing of the negative influence of the people activity on the environment is the principal, common aim of functioning environmental management systems.

An example of a formal environmental management system is a system according to ISO 14001 standard [3].

European Union, taking into account Agenda 21 guidelines, introduced in 1993 EMAS (Eco-Management and Audit Scheme) system. It was voluntarily system for industries in European Union countries wishing active working for improvement negative influence on the environment [4].

In 2001 was made review of EMAS system and introduced changes extending the range of its application [5].

Nowadays ISO 14001 and EMAS are two most important standards in the range of the environmental management. They will keep probably this character for many years [6, 7].

Thanks to EMS organizations voluntarily work out a coherent action strategy for the environment protection. It relates especially to production plants which realized different technological processes. Through analysis and modernization of technological process according to EMS requirements there is a possibility of minimization or total reduction of negative environmental influences. Because of that organizations can improve their activity [8, 9].

2. EMS according to requirements of International ISO 14001 standard

In 1992, after the success of ISO 9000 standards concerning the quality management, the ISO organization created the Technical Committee TC 207 which draft of the international standards relating to the environmental management was the task. First ISO 14000 standards (ISO 14001, ISO 14004, ISO 14010, ISO 14011, ISO 14012) were established in autumn 1996. Polish translation of ISO 14001 standard is dated on the September 1998.

Amended ISO 14001 standard was introduced on 15th November 2004, and its Polish equivalent (PN-EN ISO 14001:2005: Environmental management systems. Requirements with guidance for use) became confirmed by the Poland Normalization Committee with the date of 16th May 2005.

ISO 14001:2004 standard specified the requirements concerning the environmental management system. This approach makes possible organization working out and introducing the politics and aims taking into consideration law and others requirements which concern organization, and informations concerning significant environmental aspects.

This standard concerns these aspects, which organization identified and which can supervise and the one on which it has influence.

The following changes have been made to ISO's EMS standard, ISO 14001 [3, 10]:

- definitions – harmonized with ISO 9001:2000;
- general Requirements – EMS scope (boundaries) needs to be clearly defined;
- planning – EMS policy to be communicated to employees working on behalf of the organization; change management requirements clearer etc.;
- implementation and operation – strengthened competence requirements for persons working on behalf of the organizations; method for external communication on significant environmental aspects etc.;
- checking – documented procedure no longer required for operational monitoring and measurement; new emphasis on evaluating compliance with both legal and other requirements and compliance record keeping requirements etc.;
- management Review – input and output requirements added;
- Annex A – guidance in the Annex has been improved to cross-reference ISO 14004:2004 and ISO 19011:2002.

ISO 14001 is the standard [2]:

- general destination - it can be applied by every organization,
- pro-active - it tends towards prevention harmful influences on the environment through expectation of the environmental harmfulness risk,
- developmental - improvement of the environmental activity effects is its aim,
- voluntary - but its requirements become valid when standard will be received,
- based on systems - supported by documentary procedures.

Benefits of ISO 14001 introducing [7]:

- decrease of the working costs:
  - improvement of the raw materials used and energy consumption efficiency, decrease of waste quantity,
  - substitution of raw materials by others, without the product quality deterioration,
  - optimization of raw materials, materials and products selection,
  - increase of infrastructure used efficiency,
  - preparation of storages, packing and transportation processes,
  - reduction of waste eliminating costs and payments for using of the environment.
- fulfilment of legal requirements relating to the environment protection about waste management,
- get the better competition through ecological accommodation,
- decrease of the environmental risk through previous identifying of threats and the preparation against their appearing,
- fulfilment of clients requirements,
- improvement of the report with the environment protection services and better perception of the enterprise in the society,
- growth of the workers engagement.

3. European Eco-Management and Audit Scheme (EMAS) system

In the sequence of the accession to the European Union, in Poland was in force the Regulation of the European Parliament and of the Council called EMAS - Regulation No 761/2001 of the European Parliament and of the Council of 19 March 2001 allowing voluntary participation by organizations in a Community eco-management and audit scheme. It is called EMAS II, one of more important union legal acts referring to the environment protection sphere. It came into being after the inspection results of the first Regulation of Council (EEC) introduced 1836/93 from 23 June 1993 in the matter of the voluntary participation of industrial enterprises in the community eco-management and audit scheme. In EMAS II introduced changes, e.g. extending the range of its application. Regulation of UE no 761/2001 is application by all organizational units, not only industrial enterprises, but also every type of the utility public institutions, schools, associations etc. [11-13].

To obtain registration in the suitable national EMAS system, the organization has to meet definite conditions [12]:

- fulfils the requirements of the environmental protection law,
- initiates the system of the environmental management described in Annex I to the Regulation of EMAS,
- realizes environmental audits,

- presents the environmental declarations, confirmed by environmental verifier, in determinate deadlines in the Regulation.

The implementation of Eco-management and Audit Scheme in organization is connected with workings [13]:

- realizing the environmental review - according to the Annex VII to Regulation of EMAS,
- introducing the environmental management system full compatible with prescriptions of Annex I Part A and concerning the environmental management system requirements,
- realizing the environmental audit,
- preparation of the environmental declaration,
- verification,
- registration,
- publication of the environmental declaration.

EMAS II was strengthened by the EMAS logo which informs external subjects about the organization registration in EMAS system. The EMAS logo has three versions (Fig. 1). First two are allocated for organizations registered in EMAS (they have to possess the registration number), third can be used to the system promotion by the subject not registered in EMAS (can be used without the description).

Fig. 1. Versions of the EMAS logo [12]

4. Differences and similarities of ISO 14001 and EMAS system

The EMAS system was competitive in the relation to the system which requirements was qualified in ISO 14001 standard initially. Both adjustments were integrated after agreements through included of the environmental management system according to ISO 14001 standard to the Regulation of EMAS [11].

The structure of the environmental management systems, compatible both with ISO 14001 and Regulation of EMAS is based on the "PDCA" model (Deming model). This model leads to continual improvement based upon [14]:

- Plan - planning, including identifying environmental aspects and establishing goals,
- Do - implementing including training and operational controls,
- Check - checking, including monitoring and corrective action,
- Act - reviewing including progress reviews and acting to make needed changes to the EMS.

The EMAS system is built similarly as the environmental management system, which requirements are described in ISO 14001 (Fig. 2). Essential elements occur in EMAS, but they are not included in the ISO 14001 standard. These are: obligation of environmental declaration publishing and realization of the environmental review.

Introducing the environmental management system compatible with ISO 14001 is the first step in workings connected with the registration in EMAS (Fig. 3).

These systems taking into consideration received results; registration and control are different each other. Similarities and differences among systems were presented in Table 1.

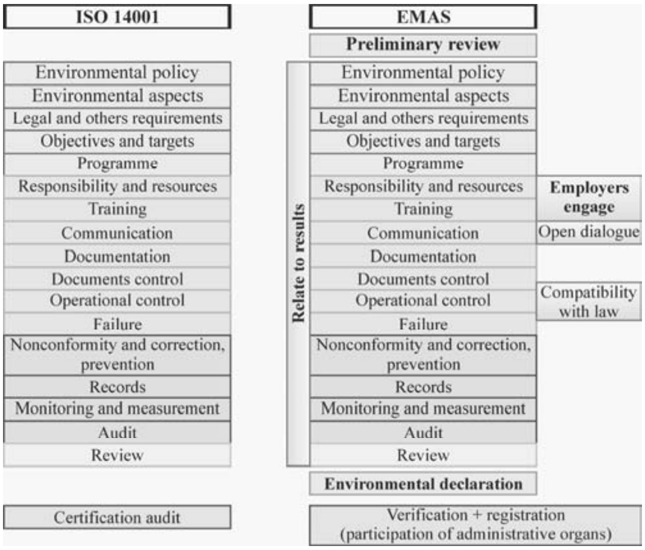

Fig. 2. Structure of ISO 14001 and EMAS system [11]

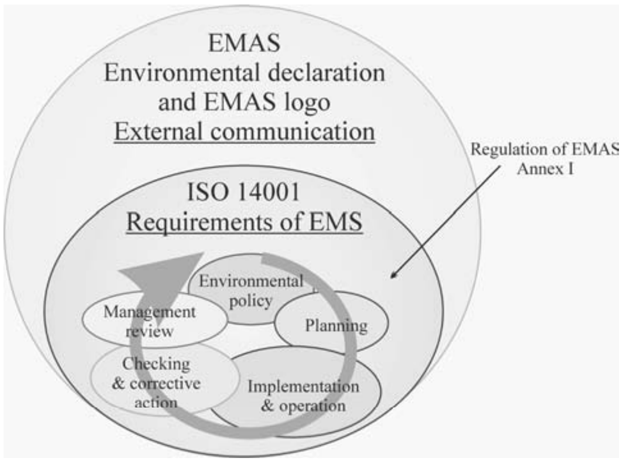

Fig. 3. Requirements of EMS [11]

Table 1.
Relations between environmental management systems [3, 5]

Characteristic	ISO 14001	EMAS
Type of system	formalised	formalised
Range of using	World	European Union
The most important requirements	EMS continuously improvement which environment purposes realization	continuously improvement of environment condition by BAT using
Estimation of results	certification audit	validation by accredited person who is set up by authority of Member State
Confirmating documents	certificate signed by accredited certification unit	attest about participation in EMAS
Registration	no international register, in Poland register is led by authorized unit of Ministry of the Economy	registration by European Community with the number conferment
Monitoring	internal audits, external audit every year, certificate renewal once a 3 years	ecological control and abidance of law prescription relating to environment protection; once a 3 years
Specification	possibility of rapid introduction on the basis of others ISO management systems	necessary of environmental reports publication which are addressed to public opinion

5. Role of EMS in search of sustainable technological process

ISO 14001 and EMAS are general and universal, so it is a possibility of using them in an arbitrary company. They are also proactive that is they tend towards to prevention by the forecast, they are voluntary, evolutionary and based on systems and procedures. The requirement of continuous improvement of the enterprises environmental situation by continuous reducing the negative influence on the environment is common principle joining all EMS.

EMAS and ISO 14001 as a formalized systems lead to creation of management systems. They fulfill the requirements of the environmental situation improvement, however unnecessarily in the result of using the preventive strategy of the environment protection. In the consequence it leads to creation of system according to definite requirements but it doesn't realize postulates of sustainable development concept.

Both systems enable and recommend usage of preventive environment protection methods towards resources reduction and minimize of energy consumption and waste quantity (or eliminate them) connected with the production process.

Above guidelines concerning total negative environmental influences reduction are basis of sustainable technological process (STP) search.

Under the definition of STP it should be comprehensible the technology which [15]:

- rationally uses sources of energy to profit in the possibly greatest degree from sources of renewable energy;
- engages possibly least resources on the unit of the product, especially relates to renewable resources;
- uses maximum renewable resources;
- eliminates the usage of toxic chemical substances which cause
- the danger for the human health and the environment;
- refers well founded and long lived product which after the end of "lives" are biodegradability and recyclable;
- eliminates the formation of waste material;
- is safety for workers and the neighbouring population.

6. Modernization of technological process towards STP achievement

6.1. Analysis of the oil filter casings production process

In this article the oil filter casings production process which is made by deep drawing technique of black plate (DC01) was analyzed. This process consists of following operations:

- materials preparation,
- plate cutting on belts or rolls,
- cutting out of definite form,
- grease coating of plate,
- deep drawing,
- side shearing,
- riveting,
- casings cleaning,
- casings drying,
- storage of casings on the palettes.

The deep drawing process of oil filters casings from black plate DC01 begins from delivery the proper material from the store. Then the cutting of sheet on belts or rolls begins. Different dimensions of sheets (mainly 0,5x1000x2000 mm) are used to production. The black plate should be cut in such way, that the least quantity of waste remain. During black plate cutting it is necessary to pay attention to lest occur material failures. Before the beginning of the deep drawing process rollers are MOLYKOTE HTF grease coated in the aim of slide, cooling guarantee, and especially the deep drawing process made easier. Then the proper deep drawing process begins. The finished product or element to production is stored in suitable containers, in the appointed place. The products which are not used updated, they are foil protected and delivered to the store. The products destined to clench a rivet should be cut, checked and then initially clenched a rivet and checked. After that, the proper clench a rivet serial process begins. The final operation of the technological process is delivering the casings from the appointed place to the washing stand, in the aim of defatting. The cleaned and checked casings are put on the palette. The palettes are delivered in the appointed place on the hall to the final control, on the store of ready products to expedition. The checked casings are put in containers or barrels.

6.2. Balance of materials, energy, waste and costs

Different dimensions of sheets (plate dimensions: 0.5x1000x2000) are used in the production process. Significant initial parameter of this process is disk diameter. Disks about dimensions ø190 mm and ø300 mm are usually used. Disks dimensions depend on final height casing which is obtained after few sheet-metal forming operations. The balance of cutting out sheets form operation is presented in Fig. 4.

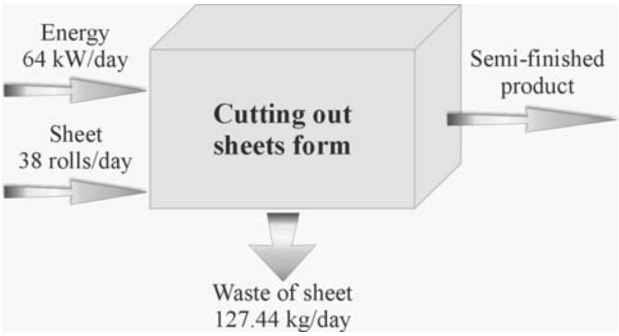

Fig. 4. Balance of materials in cutting out sheets form operation

Producer delivers MOLYKOTE HTF grease in 5 kg containers. The balance of grease coating of plate operation is presented in Fig. 5.

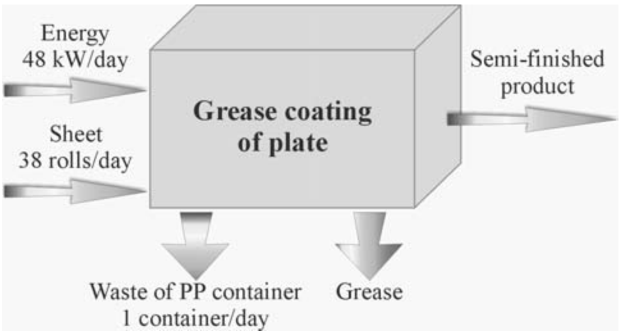

Fig. 5. Balance of materials in grease coating of plate operation

The deep drawing process consists of different heat treatment processes which are realized mainly cold working. They are used to separating, forming and joining of materials in sheets, leafs and plates form. Drawing processes in which don't separated of materials, they are individual groups (drawing – forming). The balance of deep drawing operation is presented in Fig. 6.

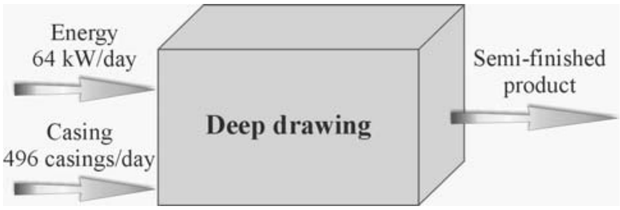

Fig. 6. Balance of materials in deep drawing operation

The side shearing operation is realized on the eccentric press. It is also used to bending, shallow and deep drawing and redrawing in all industry branches. The balance of side shearing operation is presented in Fig. 7.

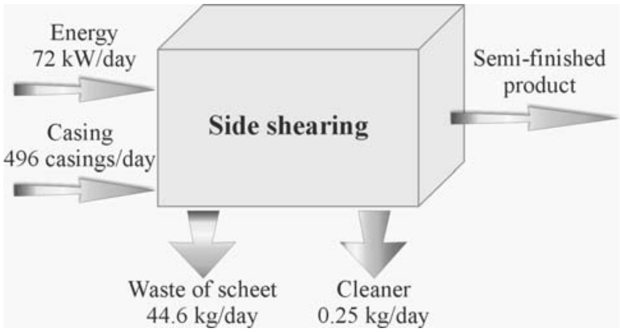

Fig. 7. Balance of materials in side shearing operation

The casings cleaning operation is realized in automatic washing dram. It is used to continuous cleaning of small details from steel, brass, aluminum and plastics. The balance of casings cleaning operation is presented in Fig. 8.

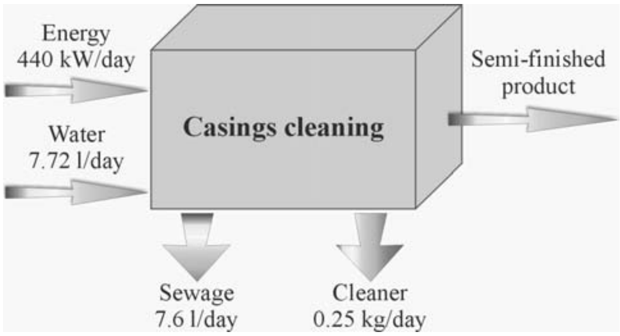

Fig. 8. Balance of materials in casings cleaning operation

The analysis of data shows that energy consumption is about 245 kWh per day.

In Table 2 and 3 presented cost analysis and waste balance in the oil filter casings production process.

Table 2.
Cost analyze of materials and raw materials used

Specification	Sheet	MOLYKOTE HTF grease	Water	Indicator of green	Cleaner	Energy
Material	0.5x1000x2000	-	-	-	100% cotton	-
Weight, unit/kg	8	5	-	1	5	-
Quantity, unit	200	20	-	1	1	-
Consumption, m^3	-	-	156	-	-	-
Unit price, PLN/m^3	-	-	6.52	-	-	-
Unit price, PLN/kg	3.9	80.00	-	20.00	0.90	-
Unit price, PLN/kWh	-	-	-	-	-	0.24
Consumption, kWh	-	-	-	-	-	7355
Total cost, PLN	6240.00	8000.00	1017.12	20.00	4.50	1765.20

Table 3.
Waste balance

Waste		
Scrap	g	4184600
PP container	unit	20
Sewage	m^3	156
Defective casings	unit	5
Cleaner	g	5000

6.3. Modernization of the oil filter casings production process propositions

After the analysis of the available technologies proposed few innovations of the technological process. The proposed changes relate to the waste processing, the change of material and the minimization of energy consumption in the process.

The presented technological process has several necessary defects to elimination. During the production waste are formed, among others:

- rests of sheet,
- used casings,
- cleaner so-called sorbents,
- sewage formed in the result of casings cleaning,
- MOLYKOTE HTF plastic containers.

The first proposed innovation concerns of oil filters use management. The oil filters used are metal containers filled filter material consisting of synthetic or natural fibres.

Thanks to applied typical mechanical technology of the oil filters recovery there are possible total recovery of basic raw materials from which oil filters consist, that is the cord - filtering input, casing – almost steel and oils rests.

Recovery method depends on waste size reduction, oil centrifuging and separating of particular fractions. As a result of this commercial material obtains. The whole installation is tight, so there are no possibilities of getting out of oil during the process of size reduction and processing.

The material and chemical recycling are used to recovery of plastics. The material recycling is usually used to products from plastics belonging to the groups of plastics about the similar properties which mixing is acceptable. The recycling depends on a products size reduction to granulated product phase without the observable changes of mechanical properties.

The chemical recycling is more expensive in comparison with the material recycling. Pyrolysis, hydrogenation, hydrolysis and dechlorination are in investigation phase yet because of high costs and lack of enough quantity of plastics to processing.

The plastic containers can be pyrolysis process subjected. Pyrolysis is a group of physical-chemical processes which should be initiated and realized to obtain the effect in the form of the thermal decomposition of the solid fuel, liquid or gas and different kind of hydrocarbons creating organic substance in waste, without the oxygen (air) fraction.

The defect of the pyrolysis is that the efficiency of its using relates to chosen group of waste which earlier should be sorted from whole mass of different waste.

The advantage of plastics liquidation in the pyrolysis process is that we can use thermal energy formed from the combustion of received pyrolitic gas - for internal needs of such waste processing plant, also.

The only one method of cleaner utilization are the installations for thermal utilization or alternatively, the resale of the cleaner used interest companies which deal with sorbents purchase. It is often incinerating plant. The main aim of it is decrease of waste quantity. The effectively working systems of the emission control supply precious raw materials. The high costs of the emission control systems are the defects of every the thermal utilization installation. The minimum efficiency of the incinerating plant is 60 000 t/year.

During the technological processes the quantities of waste form. Their management is necessary for the sake of metallurgical raw materials recovery and results from the environment protection are formed. The production and recovery of steel is the energy-saving process in comparison e.g. with production and recovery of aluminum. The advantage of steel is that it can be recovered many times without deterioration of the quality. The one of the recovery solutions of steel scrap is remelting in the steel plan. The preliminary stage of the process is obtainment of semi-finished product about specified qualitative parameters.

The second method of scrap steel disposal is the resale companies which deal with its utilization.

In the processes of sewage purification following methods are applied: chemical purification, mechanical purification, biofiltration, mixed methods and disinfection. Depending on kind of sewage the purification process should be realized with minimum costs and maximum purification degree. In this aim we can distinguish several purification methods:

- biofiltration – purification takes place with biochemical processes contribution,
- hydrobotanical – sewage treatment plant which uses floating plants (e.g. water eyelash) or enrooted (e.g. reed or water stick) to sewage purification; these systems do not use for large volume of sewage because of large unit area demand,
- chemical purification – sewage purification takes place in result of chemical processes,
- mechanical purification – sewage treatment plant in which sewage purification is realized only in result of physical processes, e.g. filtration, sedimentation; often defined as preliminary sewage treatment plant.

In practice closed water cycle is also used. It is realized mainly in these industrial plants in which sewage is strongly polluted. Closed water cycle functions as a classic urban sewage treatment plant. The only one difference depends on kind of pollutions in sewage and realization of particular purification degree.

6.4. Selection of modernization variants

For selection of modernization variants uses weighted sum method. For every solution grade scale 1-5 (1 – very weak; 2 – weak; 3 – average; 4 – great; 5 – essential) chooses and point optimization uses (Table 4).

Table 4.
Optimization point (grade scale: 1, 2, 3, 4, 5)

Criteria	(1)	(2)	(3)	(4)	(5)	Weighted sum
(1)	X	4	3	2	2	11
(2)	3	X	2	1	1	7
(3)	4	5	X	3	3	15
(4)	4	4	3	X	3	14
(5)	5	4	4	4	X	17

Legend:
(1) - Modernity of technology used;
(2) - Process simplicity;
(3) - Energy consumption;
(4) - Process costs;
(5) - Proposed innovation costs.

For group of modernization solution included:

- scrap recycling:

R1 – scrap resale companies dealing with utilization
R2 – scrap remelting for new products in steel plant

- polypropylene waste recycling from MOLYKOTE HTF grease:

R1 – material recycling
R2 – chemical recycling
R3 – pyrolysis

- sorbent recycling:

R1 – thermal utilization

- sewage purification:

R1 – close water cycle
R2 – biofiltration
R3 – hydrobotanical purification
R4 – mechanical purification.

Technological process of oil filter casings production subjected estimation according to above grades and criteria (Table 5-7).

After analysis of process modernization variants to modernization finally chosen:

- scrap resale companies dealing with utilization,
- chemical recycling of polypropylene waste,
- sewage purification in result of close water cycle,
- thermal utilization of sorbent.

Table 5.
Modernization version assessment for scrap recycling

Criteria	Weights	R1	R2
Modernity of technology used	11	3	7
Process simplicity	7	8	2
Energy consumption	15	7	2
Process costs	14	3	1
Proposed innovation costs	17	7	1
Final assessment	-	355	152
Relatively assessment	-	355/512	152/512

Table 6.
Modernization version assessment for polypropylene waste recycling

Criteria	Weights	R1	R2	R3
Modernity of technology used	11	6	7	8
Process simplicity	7	5	2	6
Energy consumption	15	5	2	2
Process costs	14	3	1	2
Proposed innovation costs	17	2	3	1
Final assessment	-	252	331	205
Relatively assessment	-	252/512	331/512	205/512

Table 7.
Modernization version assessment for sewage treatment

Criteria	Weights	R1	R2	R3	R4
Modernity of technology used	11	7	2	6	4
Process simplicity	7	8	7	2	3
Energy consumption	15	6	8	8	4
Process costs	14	6	6	4	4
Proposed innovation costs	17	4	4	5	4
Final assessment	-	375	343	341	249
Relatively assessment	-	375/512	343/512	341/512	249/512

7. Conclusions

Implementation of EMS (both ISO 14001 and EMAS) provides organizations many benefits: maximization the efficient use of resources; waste reducing; demonstrating a good corporate image; building awareness of environmental concern among employees; gaining a better understanding of the environmental impacts of business activities and increase profit, improving environmental performance.

Moreover, formalized environmental management systems ISO 14001 and EMAS help companies in accommodation to the growing requirements of the environment protection prescriptions towards sustainable development.

These profits make possible search of sustainable technological process which in practice is not obtain yet.

In this article a test of finding optimal technological processes was presented. The analysis of oil filter casings production process was proposed. In this process several modernizations were suggested. Taking into consideration weighted sum method optimal modernization variants chosen.

According to environmental management systems principle ordering continuous improvement it is necessity of continuous improvement of all technological processes.

The company which intends EMS introducing has to observe the principle.

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