



## ENVIRONMENTALLY FRIENDLY PACKAGING

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**Abstract** - *In this paper the status of package, considering its environmental impact, from raw material acquisition or generation from natural resources to the final disposal, in other words in the course of its life cycle, has been discussed. Packaging materials, first of all intended for food packaging, have been produced from metal, glass, paper, cardboard, plastics, as well as from combined materials. Packaging materials have been used in different packaging procedures. Depending on properties of packed product and on its desirable durability, food and other organics, for example, are usually subjected to various conservation procedures, before and after packaging processes. Properties of packaging materials must endure all conservation procedures without substantial changes and it must provide desired durability of packed products. Package must be also economically acceptable, and in this paper the global acceptability from the environmental point of view has been discussed. Also the possibility of applying of "environmentally friendly" label, emphasizing the sustainable development, has been analyzed. It must be also taken into account that such analysis must be done for every concrete product packed, as well as for package selected for this product, at least for group of products of the same or of very similar properties.*

### 1. INTRODUCTION

A number of factors influence the ecological status and the estimation of packaging materials and their environmental impact that can serve as a basis for characterizing them as environmentally friendly. Some of the most important are: the raw material that has been used for package production, in other words the kind of packaging material; the character of material packed, especially, the changes in package that could be caused by material packed; the energy spend during the package; life cycle of packed material, and numerous other factors.

Amongst materials that can be used for food package production, the most often metals (iron and aluminum), nonmetals (siliceous quartz sand), wood (coniferous and deciduous) and one-year plant residues (straw), as well as oil (naphtha) have been used. From the materials listed above, the metal, glass, wood, paper, cardboard, plastics, and package from combined materials has been produced. It should be underlined that such categorization has been conditioned by material dominant in package composition, having in mind that polymeric materials are present, more or less, in all kinds of package. Other raw

materials are much less used in package production and they will not be considered in this paper.

The environmental impact of package must be considered as a permanent "from the cradle to the grave" in all of phases of its life cycle. The characteristics of package, significant for the environmental impact estimation, depend on the kind of used packaging material, as well as on the kind of product packed. When considering a food, the life cycle of package or the life cycle of packed product could be analyzed separately, but with the same effect. When risky or harmful materials are packed, the used and disposed package gets the same characteristics from the toxicity point of view. In this case, the environmental impact of the packed product must be analyzed taking into account its whole life cycle, while the package must be considered as harmful and dangerous materials too.

Apart of all other factors, the consumption of energy in the course of its life cycle, very often dominantly determine the ecological status of package. In this case, calculation of energy spent per unit of mass (weight) of packed product is of special importance. Such approach gives substantially different results than this one when the energy spent per unit of produced package is taken into account.

From the point of view of the environmental impact, and especially from the aspect of the necessary environmental protection, the analysis of a possibility of introduction and application of biosynthetic and biodegradable polymer materials into package production is of special interest. It could be supposed, and first analyses confirm the absence or minimal negative environmental impact of introduction of these plastic materials into environment.

## **2. MATERIAL AND METHODS PACKAGE AND PACKAGING MATERIALS, AND RAW MATERIALS USED FOR THEIR PRODUCTION**

Various criteria for package classification have been implemented (1,2). One of them, used on the basis of packed content classify package into two groups: primary - inseparable, and secondary - separable. As a primary, the package that can not be separated from the content packed are considered and both of them, package and the product packed, make the unique entirety. This phase of package life cycle has been characterized and determined as a package waste and begins with the emptying of the packed content. In case that the content is harmful or dangerous material, than the package waste get the same properties. If the content did not have such a character, in the last phase of its life cycle, package waste will not be considered as a harmful, but as a clean package.

For package production various raw materials could be used, what causes different properties of package produced, and consequently, different fields of application, but substantially different environmental impact too. Raw materials that are used for package production could be

classified into two main groups: renewable (wood and one-year plants) and nonrenewable (all other raw materials). The largest amount of package has been produced from wood and one-year plants. Such packaging materials are paper, cardboard, and wooden package. Still, less amount of plastic package has been produced using oil as a raw material. The iron and aluminum are used for production of metal package, and quartz sand is used for glass production. In the separate group the package produced from combined materials could be classified. This package has been produced by combining two or more different materials with the aim of producing package with the best performances for specific products. Last few decades characterize the biggest rate of production and application of plastic, polymer, as well as package made of combined materials. The same trend is expected in the future, with the tendency of the decrease of mass of package per mass of packed product, what is one of the most significant principles and claims of the strategy of sustainable development in the field of packaging (3). It is also important to stress that for package production more and more secondary raw materials, more or less already used package, have been used.

From the beginning of commercial use of polymer plastic materials, from the middle of the 20th century, this kind of packaging material has recorded the biggest increase of the rate of share in the package production. Hemosynthetic polymers are used for production of plastic, and also, more or less for majority of package combined from the plastics and other materials. However, this is not the end of use of plastic materials in production of all of kinds of modern package. Namely, today probably does not exist package that not includes polymers in its composition, in that or in another form (4). For example, inner or other surfaces of metal package are protected by organic layer, lacquered or plastic polymer coated and hermetic is provided by elastomers, gum for example. Glass package is being closed using metal canes of the same composition as these used for closing metal package, and hermetic is provided by use of expanding thermoplastic materials. The field of application of paper and cardboard has been widening recently thanks to combination of these materials with waxes and coating by organic polymer plastic materials (5), especially for production of primary package. This fact is usually neglected when the ecological status of package is analyzed and discussed, because only the main constructing material is being taken into account. The basis for production of plastic package is polymer materials, usually joined with other materials, the most often with metal (aluminum) foils, paper and cardboard. The most often the method of metallization of polymer films and foils has been used recently. Also, in the last decade the more modern method of siliconization for the production of so-called quartz-like plastic materials has been used (6).

Permanently increasing demand for lowering of negative environmental impact and for the highest possible level of protection and improvement of environment by implementing the strategy of sustainable development resulted in intensified research for biosynthetic and biodegradable polymer materials production (7, 8, 9). From the environmentalist point of view, the most important properties of this new kind of plastic materials are that they can be synthesized by number of species of microorganisms, serving them as a intercellular carbon and energy source, and that these polymers are biodegradable. Several bacterial species have been investigated recently as the possible prospective biotechnological strains, for biosynthetic plastics production, but only cultivation of *Alcaligenes eutrophus* strain lead to the industrial scale of commercial production of biodegradable biosynthetic plastic known under registered name "BIOPOL®" (ICI, England). It was reported that this plastic material could be degraded by the enzyme activity of bacteria (7, 9,) and by synergistic activity of bacteria and fungi (8, 26, 27).

### **PACKED PRODUCTS**

Generally analyzing, package has several functions; one of them is a protective one, and it should provide a protection of packed product from the moment of packaging to its final use (2, 6). The main protection of packed products should be from:

- the loss and decay of mass;
- the impact of other environmental factors;
- the change no the content properties, and
- during the process of packaging, etc.

As it is already known, products subjected to the packaging processes have various properties, demanding precisely defined characteristics of package. Some of products should be protected from the loss of mass only. For such products, almost all of kinds of package could be used, and economically, the most appropriate is the use of paper package, and recently use of plastic foils. But, products having such properties are rare and much more numerous are those demanding more complex protection. Actually, the most of food and other products must be protected from the influence of environmental factors such as oxygenation, moisture, electromagnetic fields, and aromatic substances and especially from exposure to microbial activity. Also, from its packaging to the final use, the most of products should be protected from the loss of some components of packed content, such as desired amount of water, gasses, aromatic substances, etc.

In both of cases it is necessary to use the package of clearly formulated properties of barriers that are able to provide desired quality of packed content for the declared period of duration. Various products or groups of products demand different properties of package. A wide range of various conditions for package provide the majority of packaging materials except paper, cardboard and wood package, and the most often the package made of plastic polymers and plastics

combined with other packaging materials have been used. A number of products, for example food, are subjected to the processes of sterilization after being packed. Packaging of such products demands additional properties of packaging, providing that the process of sterilization does not alter the properties of packaging materials. Such demands additionally complicate the choose of packaging materials but finally, these materials could be classified into four groups: metal, glass, plastics, and package made by combining of different materials. It is necessary to stress that the first criterion for choosing the kind of packaging is always - conservation of quality and health safe product for the declared duration of time, under the demanded storage and transport conditions. Only after formulation of kind and properties, the package is analyzed considering other claimed criteria. Criterion of cost is still dominant, but in the near future it is expected the ecological acceptability to become the dominant criterion of choice.

### **PACKAGE ENVIRONMENTAL IMPACT**

Analyzing historically, considerations of the possible environmental impact of package could be classified into two periods: first - the period of taking into account the environmental impact of package waste only, and second, the period of consideration of the whole life cycle of package, from the row material use to the package waste management ("from the cradle to the grave") (10).

The used and disposed package participates in the visible part of municipal crude waste, especially if it is improperly disposed and dispersed into the environment. Not regulated relation to the package waste lead to the conclusion of the number of ecological movements that the main cause of environmental pollution was the used and improperly disposed package. In the middle of twentieth century, generally accepted concept of ecologically compatible (friendly) package was based on the criterion of environmental impact of used and disposed package waste. The paper, cardboard and wood package was considered as the most ecologically compatible. Such package does not alter the environmental equilibrium substantially. Glass and metal package was considered as less ecologically compatible. The lowest position regarding the ecological compatibility had plastic package. The reason for such relationship to the polymer materials was their resistance to the natural degradation, long persistence in the environment and long period of permanent alterations of natural relationship in the environment.

Scientific polemics at the end of last century resulted in overcoming of the concept of environmental impact of the package waste only but the whole life cycle of package: from the row material use, package production processes, packaging procedures, storage and transport, to the distribution to final user and used package disposition and management "from the cradle to the grave". The estimation of package ecological status has been defined according to ecological balance criteria, classified into two groups. First group includes criteria for

package choice according to the packed product demand (package quality) and criterion of economy (cost of package).

Second group includes the criteria of estimation of influence of package on the natural balance in the environment (environmental impact).

These criteria are numerous and related to the estimation of influence of all processes of package production and procedures of package use on the air, water and soil pollution. Any of estimation was very time consuming and detailed job, and in the most of cases the obtained result was the same or very similar when only criterion of energy consumption was applied. Such estimation was much less time consuming and the result was always acceptable. Hence, when ecological balance was mentioned, in most of cases the energy consumption as the only criterion was taken into account. Global estimation of package ecological status according to the ecological balance criteria enables the following categorization: the most appropriate ecological status has the package made of plastic polymers. Similar, but less appropriate ecological status has paper package, and other kinds of package have the lowest position regarding to their ecological status, especially regarding to the aluminum canes whose production demand the enormous energy consumption, consequently having the negative environmental impact (11). However, for final conclusion more analyses are needed.

Analyzing package ecological status, especially from the environmental compatibility point of view and regarding to the sustainable development, it must be taken into account that the estimation must be based on the application of standardized criteria and harmonized methods and tools for this criteria implementation. Every subjective appraisal (usually resulted when only the criterion of ecological balance was used) could cause negative effects in form of misunderstanding and prejudices which are very persistent and difficult to eradicate. For example, today is still used the wrong term "najlon bag" or "PVC" as a synonym for all kinds of polymers and plastic materials, but, this subject will be discussed in another paper.

### **3. RESULTS AND DISCUSSION**

#### **INTERNATIONAL AND DOMESTIC REGULATIONS**

Package as a product can be treated according to all international declarations and legislative considering environmental protection. From this point of view, attitudes and paragraphs from the strategy of sustainable development and Agenda 21 of the Rio declaration (12) could be directly implemented regarding to the package. In the same manner, other declarations and conventions of United Nations and other international associations could be implemented. European Community directives treat package as a municipal crude waste (13), but totally separated (14).

So, in 1994 the European Parliament and Council Directive 94/62/EC on packaging and packaging waste [15.] was proclaimed.

This one, as well as all other regulative from this field served as the basis for formulation of Proposition of Law on the package and package waste management of the Republic of Serbia (16). However, this Law was not ratified so far and problematic of planning, projecting, producing and package waste management has been regulated subjectively, from case to case. Special problem appears when the package waste is considered, especially because of its enormous volume fulfilling existing landfills in a very short period of time. In our country does not exist by law regulated obligation of recycling or using package as a secondary raw material, and all issues in this field depend on the private and in the most cases on individual initiative (17, 18).

#### **STANDARDS IN THE FIELD OF ENVIRONMENTAL PROTECTION**

International Standardization Organization (ISO) in the frame of series ISO 14000 is in charge for passing a standards regarding to the environment. Institute of standardization of federal Republic of Yugoslavia (Serbia and Montenegro) (JUS) is very active in this field and in very short period of time from passing new standard by ISO, translate the same, harmonize and pass a JUS ISO version. Such a prompt reaction of JUS has been realized due to the impressive activity of majority of members of Commission KS A 207, responsible for previous preparation of standards for discussion and acceptance.

Of the special significance for analyze and possible estimation of package environmental impact are standards treating the package product life cycle (19, 20, 21, 22). Such standards are formulated in the JUS ISO 64 directive for including the environmental point of view into standards for package and packed products (23). Since labels and declarations considering environmental protection (eco-labels) must be marked at the packaged product, in other words, must be stacked on the package, the standards regulating this matter are also very important (24, 25).

Without explanation of the detailed procedure of implementation of mentioned JUS ISO 14000 standards as a tool for the estimation of the ecological status of package, it must be taken into account that: Negative environmental impact the package has in the course of its whole life cycle (LC). From this reason, it is necessary to analyze the complete life cycle (LCA), to analyze the life cycle inventory (LCI) in order to enable the estimation of environmental impact of the whole life cycle (LCIA). On the basis of implemented procedure, the interpretation of the life cycle could be brought. "The aim of life cycle interpretation includes the analyze of results, bringing of decisions, explanation of limitations and providing suggestions and propositions based on previous phases (LCA and LCI studies), as well as transparent presentation of results of life cycle interpretations" (22).

User (customer) of the package or packed product must be informed in a proper way about the environmental protection, what can be achieved by labeling or marking the declaration regarding to the environmental protection on the package. The separate labeling and

declaration must be given for package waste. "The final goal of labeling, marking and declaring regarding to the environmental protection is that by means of accurate information's (which always could be checked, not misleading ones) about all aspects of products and services from the environmental protection point of view, stimulate production and delivery of those products and services without or with reduced negative environmental impact, motivating in this way marketing orientated but continual environmental protection and improvement" (24).

#### **4. CONCLUSION**

The main question of this paper is: "How to understand the way of characterization of packaging as environmentally friendly or environmentally compatible? Isn't it the way for coming to the wrong conclusion and for misunderstanding, especially having in minded that every package more or less cause negative environmental impact?"

Undoubtedly, the need for understanding of all influences of package on the environment, in the course of its whole life cycle has been imposed. Also, the package must be labeled, or must have declaration on the environmental impact, in order to be properly treated in the last phase of its life cycle, in the phase of package waste. This is the best way for definition of the package ecological status. However, if any alterations happen, in any of the life cycle phase due to the improper manipulation, the ecological status could be changed substantially. This can happen especially in the phase of package waste, when the package waste is being disposed for good, instead used as a secondary raw material for production of the same package or for other purposes. Considering this, it must be taken into account that in our country does not exist landfills constructed according to European standards, but only garbage accumulations, more often irregular than regular trash dumps.

Because of all analyzed above, it is necessary to issue the rules for package and package waste management, to provide implementation of regulations and procedures concerning package and package waste. In our country it means the urgent legislation in the field of package and package waste management. The law must have efficient instruments for the legislative implementation and sanctions against braking of regulations. Some of conditions for better environmental protection are also the increase of level of education and consciousness of population on all of age. For realization of such program it is necessary to provide also financial prerequisite, while without initial financial support, it is impossible to improve situation in this field. On the other side, reaching the certain level of package waste management could be, and in developed societies already is a highly profitable industry.

According to the discussed above it can be concluded that, as the environmentally friendly could be characterized only this package which completely protect the packed product for the declared period of duration and which during its life cycle cause minimal negative



environmental impact. Having in mind global knowledge regarding to the kinds of materials used for package production, as the most environmentally friendly we consider this made of biosynthetic biodegradable polymer plastic materials and development and commercialization of this program should be supported.

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