Chapter 10

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THE ECONOMICAL ASPECTY IN PRODUCTION TECHNOLOGY OF ACTIVE PACKAGING

Abstract: Nowadays, producers as well as consumers have very strict requirements for packaging. It should fulfill all of its functions in terms of the protection of the product, but at the same time they should be easy and fast in terms of production technology. The level of quality and sustainability of food is still increasing - that process is shaped by a new generation of packaging. Food require the use of the constantly innovating types of packaging materials. Packaging should protect the product in the highest level. Improvement of this area includes active packaging and smart packaging.

Keywords: packaging, printing technologies, instruments of improvement, management of technology

10.1. Active packaging

Active packages are distinguished by the fact that the product and its package surrounding interact with each other. The result of it is an extension of the durability and suitability of the food. Packaging technology which is used for active packaging includes only packaging material which contain chemicals or enzymes, absorbent and remove oxygen from the atmosphere from the package (DASZKIEWICZ A., DOBIEGAŁA-KORONA B.1998).

These packages inhibit the adverse effects occurring during food storage. It is based on the nature of the selective permeability to gases, through which it is possible to stabilize the composition of the atmosphere in the package.

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10.1.1 Smart packaging

Smart packaging are characteristic by the fact that there is one additional element in the package. Effect of the interaction between the packaging material and the product or the packaging material feature allows for monitoring the safety of the product during storage and transmission of the message to the client.

They prevent the lid or the bottom from ballooning or bending, they consist of a layer of material saturated with ethanol (which inhibits evaporation gradual growth of mold, yeast and some bacteria) or special inserts that increase durability of food substances. They may contain embedded in electronic packaging material changes to the storage of chemical microsensors in the product or colored indicators that indicate a leak packing, the growth of microorganisms (by responding to their metabolites) and the time and temperature of storage. For this type also include immobilized enzymes (e.g. degrading cholesterol, bind oxygen) odoriferous substances released during storage or processing of convenience food.

Experts predict that the recently launched technologies of active and intelligent packaging will have a major impact on the further development of the food industry. These packages represent a new direction in the development of food packaging technology. They contradict current efforts to eliminate any interactions between food and packaging. (SIENKIEWICZ E.2012)

10.1.2. Characteristics of the activity – printing

The newest machine for easy printing of sophisticated designs containing up to 9 colors in rotogravure technology and almost eight color UV flexo technique on substrates such as: OPP, PET, OPA, paper, aluminum foil. Print production process is controlled by a video camera system and an electronic register control system, which ensures high print

quality. The company focuses on the systematic improvement of its products, processes and services.

Fig.10.1. An example of machine used for rotogravure printing.

Source: www.alupolpackaging.eu/nadruk rotograwiurowy

10.1.3. Preparation of production

To begin the process of printing technology one should prepare the entire production process, which consists of a cylinder assembly and washing, blending and storage of cylinders. These units are responsible for the proper production process. Tasks of cylinder assembly and washing stand consist of supplying rotogravure printing machine in an appropriate set of gravure cylinders for particular contract. Printing cylinder must be prepared in accordance with the numbering contained in POZ.

The cylinder cannot have mechanical defects, it must be assigned to the relevant sections of the print with the appropriate orientation, and the surface should be thoroughly washed and cleaned. The purpose

of washing machine is cleaning all the elements of armament equipment, panels, components of rotogravure section and submission of these elements in a set. The quality of printing depends largely on the level of cleanness of machine elements. The company currently has two stores in which there are 7000 pieces of rotogravure cylinders.

10.1.4. Printing technologies used in the enterprise

The company use two printing techniques: gravure printing and flexographic printing. Another name for rotogravure is intaglio printing. In rotogravure printing forms - usually in a form of copper-clad cylinder - the printing areas are located below the non-printing areas, therefore it is a intaglio printing which is one of the direct printing methods. Rotogravure is using the printing forms in shape of cylinders. Plate cylinder is placed partially in a container of paint. The same paint is later applied to a printing form with help of rotating cylinder in the container. Above the container is squeegee which removes the excess of paint and leave it only in the recessed areas - inkstands. From the plate cylinder the paint is transferred to the substrate by pressure of the impression cylinder, which force should be relatively large to push the ink to the substrate from recessed areas.

This type of printing is most commonly used for printing high-volume magazines, books and reproductions of art as well as packaging. The advantage of this form is a wide range of mapping shades. Unfortunately it has some disadvantages: one of them is the high price of the printing.

The company also uses the UV flexographic printing. This kind of printing is characterized by soft, convex form which is made from a polymer, but also one can use a printing form made from the rubber. The technique of this kind is used when the substrate is not perfectly equal. Flexo printing is carried out almost only by making use of serial or web presses with a central cylinder. In the technology of central cylin-

der the printing forms of different colors transfer paint on a one common impression cylinder with the ink base.

Whereas in serial technology every printed form of a particular color has its own impression cylinder. With the use of the Emerald 825 machine, which has an eight-color section 9, both the sections of the printing and the printing process in 1-8 (color) takes place. They are arranged orbitally around the large common impression cylinder, and the section 9 is located at a certain distance together with the dryers thermal. Paint drying process is extremely important, so the paint does not stick to the print surface. Drying followed by ultraviolet light from lamps mounted directly behind each section printed in a distance of about 50 cm. Sections from 1 to 7 are on one lamp, section 8 has two lamps at the output in a distance of 3m. On the section 9 of the paint it can be dried by using UV lamps no.10- in case of semiflexo printing and thermal dryer divided into three parts (left, top, right) in case of roto printing. For printing flexo radical inks are used, which are characterized by a low coefficient of fragrance and high density. Radical paints have become more strong, only by the use of UV radiation. For this type of machine we use such substrates as: paper with a combination of hotmelt - which is used to print banners, metallic flexpap - which is used to print the lids and the triplet - which is used for printing bags such as the dry food.

10.1.5. Instruments of improvement

There are many elements that can help us to assess the level of quality thus to help to improve our process. One can distinguish the traditional and modern instruments of quality level. The traditional tools of quality levels are: control sheets, the correlation diagram, control charts, cause and effect diagram (also called Ishikawa diagram) which can be also used in new tools, block diagram, FMEA chart correlation, analysis of Pareto-Lorenz (PL), histograms. And the quality management instruments can include: relationship diagram, UDHR, relationship dia-

gram, diagram sagittal, matrix diagram, matrix data analysis, decision tree.

10.1.6. The quantitative instruments of the quality level

Several instruments for improvement presented on the basis of the given literature. Control sheets are one of the simplest forms of checklists. To create such a list "one must do a table in which on the one side of the list will be the kind of factors which are for example: materials, names, defects and on the other side one will write the frequency of such a factor. It is noted with the use of the conventional signs such as "by using hurdle", therefore to reduce eventual number of errors (BORKOWSKI S. 2012).

The histogram presents the data using columnar diagrams. It is used in statistics to graphically present the frequency of the random variation in a certain period (HAMROL A., MANTURA W. 2002). With the release of our volatility charts it also provides information about how decisions are made and why such decisions are taken as the first, and provides information about the process (WAWAKA S. 2002).

Analysis P-L is also called the ABCD method or the law 20-80. In the management it shows the relationship that 20% of the factors cause as much as 80% of the errors (URBANIAK M. 2001).

10.1.7. Management of technologies

The company uses the best known methods for the analysis of quality results. Such methods include various types of reports, quality control, records, reports, diagrams, for example, the diagram E, Ishikawa diagram, FMEA, 5S practice, A3 report, TPM, SMED method. The company has also introduced a program of IDEA TFI system for notifying problems. The company wants to meet the highest standards in the domestic and foreign markets that is the reason for constantly improving its processes and introduces new systems to help us achieve the highest quality standards. The most commonly used instruments for improvement in the

company are UK chart and the FMEA. Diagram analysis made it possible to separate the ten most frequent non-compliance in the enterprise. They are ranked from highest to lowest. Principle P-L says that 20% of the causes brings 80% of losses. In Figure 2 was presented graph P-L.

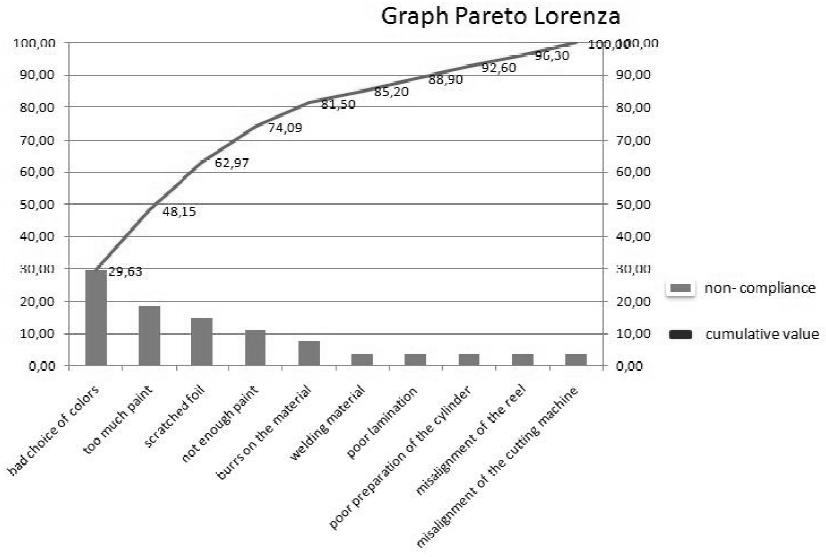

Fig.10.2. Figure P-L.

Source: own interpretation based on data from the companies.

These are: bad choice of colors (the share of the failure in the total of non-compliance (29.63%), too much paint (18.52%), scratched foil, (14.82%), not enough paint (11.12%), burrs on the material (7.41%), welding material (3.7%), poor lamination (3.7%), poor preparation of the cylinder (3.7%), improper installation of the cylinder (3.7%) and misalignment of the reel (3.7%). By using the diagram P-L company can quickly and most importantly cost-effective way determine what factors affect the growth of non-compliance. After determining non-compliance,

workers make adjustments in the place of the defect. Another method which the company uses to analyze the quality of results, thus can easily provide quality problems is the FMEA.

Description of the table:LPO-is the number of occurrence, it represents the probability of non-compliance (1 - low, 10 high) PAP-number S represents the effects of non-compliance, determine the validity of non-compliance to the customer (1 - very small, 10 - large), LPW-shows the number of detection that is difficult to detect the inconsistency before leaving the factory the product of (1 - easy, 10 - hard) LPR-risk priority number.

LPR Index is less than 100, this means that the level of analysis is acceptable. If any of the defects was more than an acceptable level would mean that they do not meet the standards, and therefore contributes to the deterioration of the material. Complete removal of defects is impossible, but there should be proposed measures which aim to increase the detection or reduce the negative effects of their occurrence. The enterprise does not need to make corrective actions because LPR indicator is an acceptable level. The enterprise can monitor the production process and if there is possibility the company can lead some corrective action. The firm cannot forget about monitoring the preventive and corrective actions. The results of these actions should always be evaluated by the FMEA. In Table 1 is shown in the FMEA analysis in the company.

Table 10.1. The FMEA analysis for the bobbin

Number of the error	Defect	Effect	Main reason	LPO	LPZ	LPW	LPR	Corrective action
1	wrong selection of colors	Too intense colors or the absence of color.	wrong data entered into the control system of the machine	6	3	5	90	training of the printing machine operator
2	too much paint	too heavy material, paint is smearing	wrong metering of paint by a machine.	4	4	5	80	replacement of the dispenser
3	scratched foil.	clearances in the material.	Inaccurate cleaned cylinder	2	7	4	56	accurate checking of the cylinder before installing it in the machine.
4	Too small amount of paint.	clearances in the material.	wrong metering of paint by a machine.	3	5	3	45	replacement of the dispenser.
5	inequalities on the material.	scratching material.	unclean machine	4	5	2	40	cleaning the machine after each bobin
6	heat sealing of material	collapse the of the material	improper temperature, too much glue	3	6	2	36	installing a controller of temperature
7	incorrect lamination	collapse the of the material	improper temperature	3	6	2	36	installing a controller of temperature
8	poor preparation of cylinder	pollution of the material	unclean machine	3	6	2	36	sterilization at higher temperatures

9	improper setting cylinder	color distortions on the material.	a hurry of the employee	3	6	2	36	inspection carried out by senior staff
10	Incorrect setting of the cutting machine	too narrow / too wide strips of material	wrong measurements made by the operator.	3	6	2	36	employee read carefully POZ instruction

Source: own interpretation on the basis of the information obtained in the Enterprise

FMEA analysis showed that most of the problems in the process made a bad choice of colors, which is 90 LPR (this is a risk priority number). The reason to choose the wrong color is the introduction of bad data into the machine control system. Too large amount of paint on the material, also reduces the attractiveness of the product it amounts to (80 LPR). The factor of occurring such non-compliance is wrong dosage paint by printing machine. Scratch foil (56 LPR) also contributes to the formation of non-compliance on the material. The scratch of the foil are caused by careless cleaning the cylinder. These discrepancies eliminate the material that has to do anything to no avail. It shall be sold to a company that uses this material to much other purposes. Least incompatibility occurs when: welding material, laminating, preparing the cylinder, the cylinder assembly and set the cutting machine is only a (36 LPR).

10.2. Management of technologies

The article included information on the company, which is engaged in production of flexible packaging in the domestic and foreign market. This paper describes the process of pre-production as well as two printing techniques that are used in rotogravure printing plant and flexographic

printing. This paper describes the process of pre-production as well as two printing techniques which are applied: rotogravure printing and flexographic printing. There was also presented at the same time improving the existing instruments supported by literature on the subject. The company uses most of these instruments, what was shown in the last subchapters.

Bibliography

1. BORKOWSKI S. 2012 *Nowoczesne narzędzia zarządzania jakością. Teoria i praktyka*. Wydawnictwo Stowarzyszenie Menedżerów Jakości i Produkcji. Częstochowa.
2. BORKOWSKI S. 2012 *Tradycyjne narzędzia zarządzania jakością. Teoria i praktyka.* Wydawnictwo Stowarzyszenie Menedżerów Jakości i Produkcji. Częstochowa.
3. ĆWIKLICKI M., JABŁOŃSKI M. 2009 *Konsulting. Uwarunkowania i perspektywy rozwoju w Polsce.* Wydawnictwo Poligrafia ITS. Kraków.
4. DASZKIEWICZ A., DOBIEGAŁA-KORONA B.1998 *Opakowanie. instrument marketingu.* Wydawnictwo Centrum Informacji Menedżera. Warszawa.
5. HAMROL A., MANTURA W. 2002 *Zarządzanie jakością. Teoria i praktyka.* Wydawnictwo Naukowe PWN. Warszawa.
6. KINDLARSKI E. 1993 *Wykresy Ishikawy i Pareto. Zarządzanie przez jakość*. Wydawnictwo Bellona. Warszawa.
7. MATUSZAK-FLEJSZMAN A., ŁUCZAK J. 2007 *Metody i techniki zarządzania jakością: kompendium wiedzy*. Wydawnictwo Quality Progress. Poznań.
8. SIENKIEWICZ E.2012 *Nowoczesne opakowania żywności* (artykuł z Internetu)
9. STEWART B. 2009 *Projektowanie opakowań*. Wydawnictwo Naukowe PWN. Warszawa.
10. URBANIAK M. 2001 *Zarządzanie przez jakość.* Wydawnictwo Wielkopolska Szkoła Biznesu: Fundacja „Kadry dla Wielkopolski". Poznań.
11. WAWAK S. 2002 *Zarządzanie jakością. Teoria i praktyka.* Wydawnictwo Helion. Gliwice.