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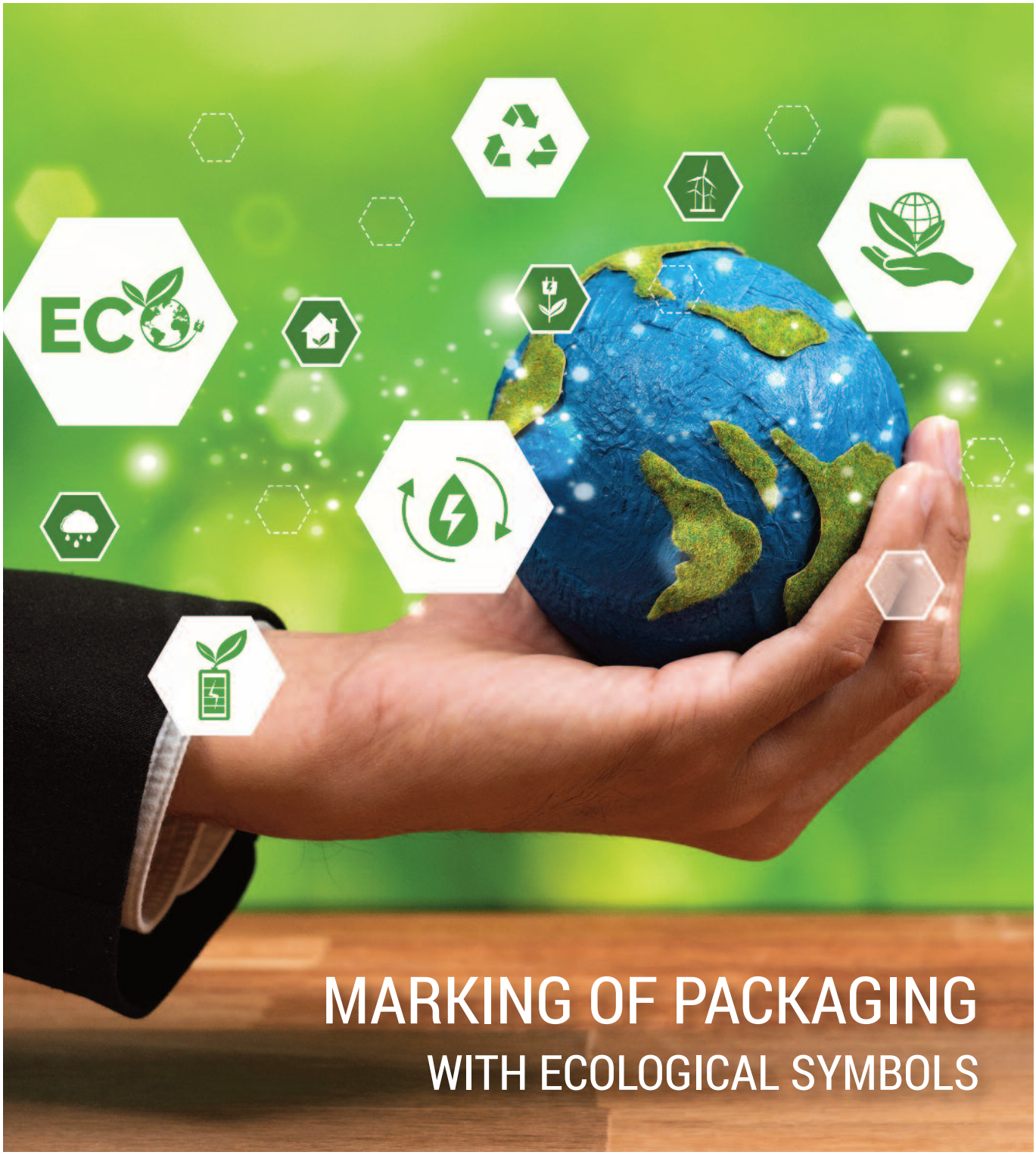

MARKING OF PACKAGING
WITH ECOLOGICAL SYMBOLS

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Dear Readers!

At the initiative of the Chamber of Press Publishers and a number of scientists, publishers, journalists and industry professionals, a letter was sent to the Minister of Science and Higher Education, Dariusz Wieczorek, regarding the scoring rules for scientific and trade journals. The current scoring system does not encourage Polish scientists to publish articles in national scientific and professional journals. The letter contains specific solutions proposals to restore the professional press to its due role in the synergy of science and the economy, which is realized, among other things, through the promotion of scientific research results and Polish scientific and technical development.

The importance of the trade press to national professional practice in numerous industries, and thus to the economy, is enormous. The relationship between professional practitioners and scientists, provided by trade journals, is also of great importance to the development of Polish science. It is therefore necessary to include professional press in the journal scoring system and to introduce stable evaluation rules. Understanding the importance of the postulates raised by the Chamber, the letter received broad support from the scientific community, technical associations, representatives of universities, institutions and industry organizations. The Chamber of Press Publishers and the other signatories of the letter point to the urgent need to improve the situation of the trade press sector, which can positively influence the improvement of cooperation between editors and publishers and representatives of science, as well as the effective implementation of scientific achievements in the Polish economy. Supporting the letter, numerous industry organizations, academic circles and publishers look forward to the actions of the authorities and the imminent introduction of such changes in the current scoring rules that will reflect their expectations and enable Polish experts to communicate their expertise in the pages of national scientific and industry journals.

The full content of the Chamber's letter to the Ministry of Science and Higher Education, along with the list of signatories, can be read at the link below: https://opakowanie.pl/wp-content/uploads/2024/05/List_do_MNiSW_z_podpisami.pdf

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Drodzy Czytelnicy!

Z inicjatywy Izby Wydawców Prasy oraz szeregu środowisk naukowych, wydawców, dziennikarzy, branżystów, został wystosowany do Ministra Nauki i Szkolnictwa Wyższego Dariusza Wieczorka list w sprawie zasad punktacji czasopism naukowych i branżowych. Obecny system punktacji nie zachęca polskich naukowców do publikowania artykułów w krajowych czasopismach branżowych o charakterze naukowym i fachowym. List zawiera konkretne propozycje rozwiązań mających przywrócić prasie fachowej należną jej rolę w zakresie synergii nauki i gospodarki, która jest realizowana m.in. poprzez propagowanie wyników badań naukowych i rozwijanie polskiej myśli naukowo-technicznej.

Znaczenie prasy branżowej dla krajowej praktyki zawodowej w licznych branżach i tym samym dla gospodarki, jest ogromne. Zapewniana przez fachowe czasopisma relacja praktyków zawodowych z naukowcami, ma też ogromne znaczenie dla rozwoju nauki polskiej. Niezbędne jest więc uwzględnienie prasy fachowej w systemie punktacji czasopism i wprowadzenie stabilnych zasad ewaluacji. Zrozumienie wagi postulatów podnoszonych przez IWP spowodowało, że list Izby zyskał szerokie poparcie środowisk naukowych, stowarzyszeń technicznych, przedstawicieli wyższych uczelni, instytucji i organizacji. Izba Wydawców Prasy i inni sygnatariusze listu wskazują na pilną potrzebę poprawy sytuacji sektora prasy fachowej, co może pozytywnie wpłynąć na poprawę współpracy redakcji i wydawców z przedstawicielami nauki oraz efektywne wdrożenia osiągnięć nauki w polskiej gospodarce. Popierające list liczne organizacje branżowe, środowiska akademickie oraz wydawcy, z nadzieją oczekują na działania władz i rychłe wprowadzenie takich zmian w obowiązujących zasadach punktacji, które odzwierciedlą ich oczekiwania i umożliwią polskim ekspertom przekazywanie fachowej wiedzy na łamach krajowych czasopism naukowych i branżowych.

Z pełną treścią listu IWP do MNiSW wraz z listą sygnatariuszy można zapoznać się pod linkiem: https://opakowanie.pl/wp-content/uploads/2024/05/List_do_MNiSW_z_podpisami.pdf

Packaging Review

Issue **2/2024** includes:

REVIEWED ARTICLES <<

INDUSTRY EVENTS <<

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MARKING OF PACKAGING WITH ECOLOGICAL SYMBOLS

AKTUALNA SYTUACJA ZNAKOWANIA ŚRODOWISKOWEGO OPAKOWAŃ / ZNAKOWANIE ŚRODOWISKOWE OPAKOWAŃ / OZNACZANIE OPAKOWAŃ SYMBOLAMI ŚRODOWISKOWYMI

ABSTRACT: Do you know how to mark correctly the packaging? The situation connected with the environmental marking of packaging is somewhat difficult. There is no uniform approach to marking issue in the European Union. The binding rules are insufficient and remain too large freedom in this respect – it causes, in turn, the fact that some countries have commenced to create their own initiatives and introduce their own principles concerning labelling.
The present paper is an attempt to organize the knowledge concerning the environmental marks on the packaging. It includes the discussion of the basic groups of the signs together with the guidelines relating to their application. The text refers also to the present and obligatory legal acts, existing in Poland. In the paper, the problems of different requirements concerning packaging marking in different European countries have been discussed.
Key words: environmental marks, eco-marks, sustainable development, recyclability, greenwashing, circular economy (GOZ)

STRESZCZENIE: Czy potrafimy prawidłowo oznaczać opakowania? Sytuacja związana ze znakowaniem środowiskowym opakowań jest dosyć trudna. W UE nie ma jednolitego podejścia do tematu znakowania. Obowiązujące przepisy są niewystarczające i pozostawiają zbyt dużą dowolność w tym zakresie - to z kolei powoduje że, niektóre kraje zaczęły tworzyć własne inicjatywy i wprowadzać własne zasady dotyczące znakowania.
Poniższy artykuł stara się uporządkować wiedzę dotyczącą znaków środowiskowych na opakowaniach. Omówione w nim zostały podstawowe grupy znaków wraz z wytycznymi co do ich stosowania. Tekst odwołuje się do też, do istniejących i obowiązujących w Polsce aktów prawnych. A także porusza problematykę różnych wymagań dotyczących znakowania w różnych krajach Europy.
Słowa kluczowe: znaki środowiskowe, eko-znaki, zrównoważony rozwój, przydatność do recyklingu, greenwashing, GOZ

For a long time, the role of packaging has extended its basic protective role. To-day, the packaging has to attract the attention, initiate the purchase and also, pay the informational role.

The information present on the labels should be reliable, transparent and easy to understand and they should not mislead the customer in the respect of the properties, effect or features of the product. The majority of the guidelines concerning the type of information which should be present on the packaging are referred to the packaged product and it is the obligatory information.[1] Apart from the lot of information on the label, we may also find different types of pictograms, signs and graphic symbols.

The marks on the packaging may concern the contents of the packaging transport conditions and handling as the packaging itself. One of the most frequently met signs concerning the packaging includes the environmental marks, playing a significant role in the increasingly ecology-aware world. The consumers want to be better informed about the effect of their purchase decisions on the environment and they want to make well informed choice. Unfortunately, we have to-day the situation of enormous quantity of marks and pictograms and the information contained on the packaging is not always true and completely understandable. The aim of the present paper

is to make the order in respect of the existing information about environmental marking of the packaging.

Due to the supplied information, the environmental marks may be classified into the following types:

– marks concerning the composition of the packaging – including the signs of material identification; the signs, specifying the content of recycled material, or the marks informing about the content of plastics;
– marks, informing about the properties of the packaging, satisfying the specified requirements, connected with the environmental protection such as recyclability or compostability;
– other signs – including the marks indicating the appropriate handling of the packaging after its use, or the signs of membership to the organizational-legal system, connected with the waste management.

In the EU countries, according to the recommendations of Directive 94/62/EC, Decision of the European Commission 97/129/EEC of January 1997, the voluntary system of identification of packaging material was introduced (ID-identification system).[2,3] The mentioned system specifies the symbols of packaging material and the code numbers, corresponding to the discussed materials. Annexes I-VII of the mentioned above document contain the symbols of materials and the corresponding numerical codes which have been given in Tab.1. Annexes I-VI concern the uniform materials (plastics, paper, metal, wood, textiles, glass) whereas Annex VII is referred to multi-material packaging. For the multi-material packaging, the letter C and the symbol of predominant (in mass) material is provided. For example, the symbol of material for packaging produced from laminate: cardboard/aluminium/polyethylene is C/PAP (C/symbol of predominant material, i.e. PAP cardboard).

In Poland, the Regulation of the Minister of Environment dating to 3 September 2014 on the patterns for marking of packaging [4] is, at present, the obligatory rule; it specifies the detailed principles of marking the packages, and it has been developed on the grounds of guidelines and decisions of the European Union, and, in particular, Directive 94/62/EC of the European Parliament and of the Council of 20 December 1994 on packaging and packaging waste (Official Journal L 86 of

TAB.1. SYSTEM OF IDENTIFICATION PURSUANT TO DECISION 97/129/EC

Annex	Type of material	Material	Symbol	Numerical code
I	Plastic	Polyethylene terephthalate	PET	1
		High-density polyethylene	HDPE	2
		Vinyl polychloride	PVC	3
		Low-density polyethylene	LDPE	4
		Polypropylene	PP	5
		Polystyrene	PS	6
II	Paper and cardboard	Corrugated cardboard	PAP	20
		Cardboard different than corrugated cardboard	PAP	21
		Paper	PAP	22
III	Metal	Steel	FE	40
		Aluminium	ALU	41
IV	Natural	Wood	FOR	50
		Cork	FOR	51

Annex	Type of material	Material	Symbol	Numerical code
V	Textiles	Cotton	TEX	60
		Jute	TEX	61
VI	Glass	Colourless glass	GL	70
		Green glass	GL	71
		Brown glass	GL	72
VII	Multi-material	Paper and cardboard/different metals	C/*	80
		Paper and cardboard/plastics	C/*	81
		Paper and cardboard /galvanized steel sheet/aluminium	C/*	82
		Paper and cardboard /galvanized steel sheet	C/*	83
		Paper and cardboard/ plastics/aluminium	C/*	84
		Paper and cardboard /plastics/aluminium/galvanized steel sheet	C/*	85
		Plastics/aluminium	C/*	90
		Plastics/galvanized steel sheet	C/*	91
		Plastics/different metals	C/*	92
		Glass/plastics	C/*	96
		Glass/aluminium	C/*	97
		Glass/galvanized steel sheet	C/*	98
		Glass/different metals	C/*	99

* Mixed materials: C plus abbreviation corresponding to dominant material

5.04. 2005, p.6) and the Commission Decision 97/129/EC of 28 January 1997/

The symbols identifying packaging material cannot be identified with the suitability to recycling (recyclability)[5]. Their aim is to improve the recovery of the recyclable materials via their correct identification. Currently in Poland the system of marking is voluntary but if the entrepreneur decides to use it, it must be consistent with the legal regulations.

It is worthy to mention that the draft PPWR Regulation (Packaging and Packaging Waste Regulation) envisages introduction of a duty of material identification of packaging[6]. It means that each packaging shall possess a label, containing information about raw material composition. The mentioned duty will not refer to transport packaging. The Commission will undertake also standardization of formats and requirements in respect of packaging labelling. It concerns, inter alia, information about the content of material coming from recycling or the content of bio-derived raw materials. We have, however, to wait a while for the defined guidelines. The Commission makes the obligation to issue the respective acts at the period up to 18 months since the entry of the discussed Regulation into effect.

TAB.2. THE PATTERNS OF THE HDPE PACKAGING MARKING ACCORDING TO THE REGULATION OF THE MINISTER OF THE ENVIRONMENT OF 3 SEPTEMBER 2014

2	High density polyethylene	

At present, the producers are obliged to place the appropriate marks on the single-use plastic packaging, informing about the content of plastics and the relating threat to the environment (Fig.1).

In connection with the introduction of the Act of 14 April 2023 on the change of the act on the duties of entrepreneurs in respect of management of certain waste and on the product

fee, there has been imposed the duty on the producers to mark certain packaging[7]. The amendment results from the implementation of the EU Directive of 5 June 2019, being known as SUP Directive (Single-Use Plastic Directive)[8]. The aim of the mentioned Directive is to reduce the impact of certain single-use products and plastic fishing-related items on natural environment.

The single-use plastic products covered with the marking requirements include as follows:

1) sanitary pads and tampons and applicators for tampons;
2) wet wipes;
3) tobacco products with plastic-containing filters and filters, containing plastic; and
4) cups for drinks and beverages.

The marks informing about the content of renewable raw materials in packaging are still a relatively new variety of ecological signs. The mentioned system may be applied in relation to many products, being totally or partially produced form natural-origin materials (excluding solid, liquid and gas fuels). To apply for certification, the product must contain at least 20% of organic carbon from renewable resources. In 2015, COBRO introduced program for certification of the renewable raw material content in packaging products, introduced into the domestic market. There is given below the marking employed by different units in order to distinguish the products produced from renewable raw materials.

The group of marks concerning the composition of the packaging includes also FSC mark (Forest Stewardship Council International) – the most recognisable mark all over the world, the mark informing about the sustainable forest management (Fig.3). FSC label confirms that the timber or wood fibres used in manufacture of a defined product come from the certified forests. The certified forests are those ones which are managed in compliance with FSC requirements. FSC certificate is intended for all entities of wood and paper sector which possess legally obtained raw materials or products[9].

Another group of marks includes declarations (claims) and marks that confirm meeting the specified environmental requirements. The mentioned marking is employed as an

FIG.1. THE OBLIGATORY MARKING OF THE PRODUCTS, COMPLIANT WITH THE SINGLE-USE PLASTIC DIRECTIVE

FIG.2. EXAMPLES OF MARKS, INFORMING ABOUT THE CONTENT OF RENEWABLE RAW MATERIALS

FIG.3. FSC FOREST STEWARDSHIP COUNCIL MARKS

indispensable instrument of communication in green marketing; however, due to a lack of transparent legislation, they do not always reflect the real properties of packaging. The study of the European Commission of 2020 revealed that 53.3% of the examined statements concerning environmental protection in the EU were recognised as unclear or misleading and 40% were unjustified[10]. Lack of common rules for the enterprises which declare voluntary claims in respect of eco-friendliness leads to malpractice and works against the companies which act, in fact, in accordance with the principles of sustainable development. Moreover, a high freedom in application of the signs causes that the consumers feel confused and lose their confidence in reliability of eco-marking.[11]

FIG.4. "MÖBIUS LOOP" – SYMBOL OF RECYCLABILITY ISO 14021:2016

FIG.5. PERCENTAGE VALUE OF RECYCLED CONTENT

The EU has undertaken the measures, aimed at the protection of the consumers from "greenwashing" and pseudo-ecological declarations on the packaging[12]. The task of Directive of the European Parliament and of the Council on substantiation and communication of explicit the environmental claims (Proposal for a Directive of 22 March 2023, Green Claims Directive) to make that the claims concerning environment are reliable, comparable and verifiable in total EU. The environmental claims being not supported by the studies will be forbidden. The discussed document contains the guidelines concerning the correct application of green claims. The ban will cover, inter alia, the following cases:

- marking concerning the sustainable character that is not based on the system of certification and has not been established by public organs;
- general environmental claim for which the entrepreneur is not able to indicate the recognised high environmental effectiveness, being relevant for the discussed claim, e.g.: eco-friendly, green, friendly to nature;
- environmental claim in relation to the whole product whereas it refers only to a certain aspect;
- presentation of the requirements imposed by law on all products belonging to a respective category of products at the EU market as the property, that distinguishes the offer of a given entrepreneur.

The marking connected with recyclability is nowadays one of the most popular environmental claims. Thus, the information about the limited burden of packaging to the environment, as a result of their reuse, is made available.

The basic international mark of recycling is a symbol, composed of three subsequent arrows, distributed on the plane of triangle in a form of the so-called Möbius loop (or strip) acc. to ISO 14021[13]. Each of three arrows illustrates one stage of three-degree loop of recycling, i.e. collection, processing and sale together with use of the products, manufactured from materials, processed during the recycling process. The discussed sign is also associated with the motto "3R": Reduce, Reuse, Recycle, being the encouragement for protection of the environment in result of minimization of the waste amount, secondary use of products and packaging and recycling. A similar symbol with a given percentage value signalizes that a defined part of the product was made from processed materials.

In Poland, the Regulation of the Minister of Environment of 3 September 2014 on the patterns for package marking has determined the model of the packaging marking, indicating the suitability of the product for recycling (recyclability) (Fig.6), and the symbol of the suitability for reuse (Fig.7). The mentioned symbols may be employed in the case of meeting the requirements of standards PN-EN 13430:2007 "Packaging – Requirements for Packaging Recoverable by Material Recycling" or PN-EN 13429 "Packaging – Reuse"[14,15].

In our country, COBRO, as under the structures of the Institute of Technology of Łódź, has conducted - since 1993 - a voluntary certification of packaging suitable for re-processing. It has been the first certification in Poland which concerns evaluation of packaging in aspect of one of the ecological criteria. The producer of packaging, who obtained the discussed certificate, is entitled to put the special mark on the packaging.

Symbols of suitability for organic recycling, i.e. for biodegradation and composting are a similar group as the discussed above and are given in figure below.

The last, third group of symbols includes, inter alia, the symbols indicating the way of the waste removal. Fig.10 – Take Care of Cleanliness – reminds about the necessity of disposing of the used product via its throwing out to waste bin.

Lack of uniform regulations in respect of packaging marking at the European level caused that certain Member States of

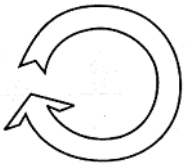

FIG.6. SYMBOL OF RECYCLABILITY

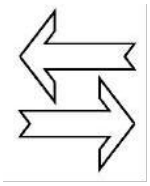

FIG.7. SYMBOL FOR REUSABLE PACKAGING

REGULATION OF THE MINISTER OF ENVIRONMENT OF 3 SEPTEMBER 2014 ON PATTERNS OF PACKAGING MARKING

FIG.8. SYMBOL FOR RECYCLABLE PACKAGING, USED BY COBRO

FIG.9. THE EXAMPLES OF SYMBOLS, INFORMING ABOUT THE SUITABILITY OF PACKAGING FOR COMPOSTING AND BIODEGRADATION

the EU and Great Britain developed their own initiatives concerning, inter alia, logo of recycling. The mentioned limitations affected considerably the companies which run commercial activities in different countries.

The example may be France where since 9 March 2023, it is obligatory to use Triman logo on all the packaging directed to consumer. Triman logo (Fig.11) informs the consumers about the possibilities of recycling of a given product and indicates

FIG.10. SYMBOLS INDICATING THE APPROPRIATE (CORRECT) DISPOSAL OF PACKAGING AFTER ITS USE

FIG.11. TRIMAN LOGO

where the packaging should be thrown away (to which stream of waste it should be directed).

In Italy, there has been introduced a duty of environmental marking of packaging. Since January 1, 2023, the packaging must be marked in the way compliant with the new national regulations.

The above examples show only some of the encountered challenges, connected with the lack of uniform legislation concerning packaging in the EU.

Summing up, it should be concluded that there is no possibility to pass into circular economy (GOZ) model without involvement of all stakeholders. The properties of packaging alone as being based on the principles of GOZ are not sufficient to ensure the profits to the environment; they have to be accompanied by the will of the consumers to buy the mentioned sustainable products. The correct eco-labelling may have a real impact on shaping of the consumer choices, consistent with the circular economy. The discussed situation may have place only when the marking is reliable, understandable and honest.

The support should come from transparent legislation, being coherent in the total EU. A step towards good direction would be facilitated by the regulation concerning voluntary environmental claims and the proposals contained in (PPWR) Proposal Packing and Packing Waste Regulation). Hopefully, the matter of uniform marking of packaging product may be regulated soon so as the environmental marking could be not only the excellent marketing gimmick but also a manifestation of real care of the environment.

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ANALYSIS OF THE QUALITY OF UNPRINTED VARNISHED FOLDING BOXBOARD AND THAT ONE, PRINTED BY DIGITAL ELECTROPHOTOGRAPHIC TECHNOLOGY WITH THE USE OF DRY TONER

ANALIZA JAKOŚCI LAKIEROWANYCH TEKTUR PUDEŁKOWYCH NIEZADRUKOWANYCH ORAZ ZADRUKOWANYCH TECHNIKĄ CYFROWĄ ELEKTROFOTOGRAFICZNĄ Z TONEREM SUCHYM

ABSTRACT: In the present paper, the visual and touch-sensitive analysis of box cardboards with the refining layer in a form of varnish has been carried out. The experiment was conducted in cooperation with Konica Minolta company. Three different substrata without printing and the coated printed cardboard, using three different electrophotographic machines have been covered with varnish. Then, the visual effects and the obtained layer have been compared according to the thickness of the employed layer.
On the grounds of the conducted tests, it has been determined what the possibilities of varnish coating were, and what type of box cardboards was the best one in the process of varnish refining.
Key words: digital printing of packaging, refining of packaging, ink-jet UV varnishing, ecological printing

STRESZCZENIE: W ramach niniejszego artykułu, dokonano oceny wizualnej oraz dotykowej tektur pudełkowych z warstwą uszlachetnienia w postaci lakieru. Badanie zostało przeprowadzone we współpracy z firmą Konica Minolta. Zalakierowane zostały trzy różne podłoża bez zadruku oraz tektura powlekana zadrukowana przy wykorzystaniu trzech różnych maszyn elektrofotograficznych. Następnie porównano efekty wizualne i uzyskaną warstwę lakieru w zależności od grubości warstwy, jaka została nałożona.
Na podstawie przeprowadzonych badań określono, jakie są możliwości lakierowania, a także który rodzaj tektur pudełkowych najlepiej się sprawdza w procesie uszlachetniania lakierem.
Słowa kluczowe: drukowanie cyfrowe opakowań, uszlachetnianie opakowań, lakierowanie ink-jet UV, drukowanie ekologiczne

1. INTRODUCTION

In the period of decreasing volume of printed materials and the possibility of obtaining digital prints of a very good quality, the producers of packaging decide, more and more frequently, to utilize digital electrophotographic or spray devices in the implementation of their orders. They apply also successfully refining, e.g. in a form of varnishing, what increases the colour depth of prints and, by this, affects positively the aesthetic impressions of the customers. At present, it is difficult to distinguish which packaging has been printed by classical technology (e.g. offset) and which was made with the application of digital technology. It has a great meaning for printing house, possessing – more and more often – digital machines which solve the problem of "disintegrated" orders (i.e. the increased

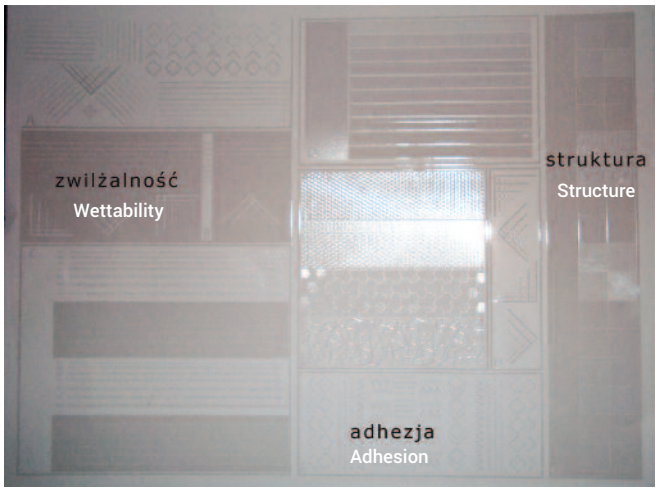

FIG.1. TEMPLATE OF APPLYING A LAYER OF VARNISH

SOURCE: THE SAMPLE PERFORMED IN PAINTING FACILITY OF KONICA MINOLTA COMPANY

number of orders but usually of a small volume). Moreover, digital printing is more ecological than the offset because it generates much less waste. Today, the ecology is also the important problem for all packaging producers [1].

PARAMETERS OF VARNISHING PROCESS

When performing the test printing with the applied layer of varnish, the template released by Konica Minolta company was used; it is employed for checking of the quality of the product with the applied varnish layer. When analysing the quality of the varnished box cardboard, the attention was paid to adhesion, that is, capacity to surface linking of varnish and substratum particles and, also, to absorption, that is, how the substratum absorbs the laid varnish. The wettability, i.e. capacity of varnish to cover the prints completely was also examined. To be possible, the surface tension of varnish must be lower than the surface tension of substratum and paint.

Figure 1 shows a fragment of template from which the properties of the samples were read out.

Parameters of machines used for performance of the samples

To apply a layer of varnish, the machine by Konica Minolta MGI JETVARNISH 3D One, was employed. It is used for a selective application of varnish on paper or cardboard. It is an ink-jet UV varnishing technology and the thickness of the applied layer was equal to 21 micrometers.

In Table 1, the parameters of machine have been presented.

AccurioPress c1200 machine is a digital device by Konica Minolta company. It has been used for printing of apla (uniform colour plane) with components of CMYK colour.

Table 2 shows the parameters of the machine.

Xerox 770 Digital Color Press machine is a digital colour device by Xerox company. It was employed in printing of apla with the components of CMYK colour.

In table 3, the parameters of the mentioned machine have been presented.

TABLE.1. SPECIFICATION OF VANISHING MACHINE

Printing technology	Technology of ink printing MGI; Technology Drop-on-Demand (DoD); Piezoelectric printing heads of Konica Minolta company One run printing; Flexible and scalable architecture of print;
Coat thickness	Coat thickness is dependent on surface of substratum and paint; On laminated coats and those based on water solutions: 21µm – 116 µm For effects of convex texture 3D at finish making the touching impressions; On toner and paper or coated cardboard: 30 µm – 116 µm For effects of convex texture 3D at finish making the touching impressions;
Production yield	in mode 2D/flat: up to 2077 sheets A3 per hour (21 µm); in mode 3D/raised up: up to 1260 sheets A3 per hour (51 µm); up to 547 sheets A3 per hour (116 microns);

Fitting	SmartScanner in combination with the solution of Artificial Intelligence (AIS) ensures completely automated system of fitting between the sheets at a real time
Formats	min. 210 x 297 mm; max. 364 x 760 mm; max. width of print 353 mm;
Substratum thickness	min.: 135 g/m² and not less than 150 µm or 6 mm before printing and lamination max.: 450 g/m² and not less than 450 µm or 18 mm before printing and lamination engine-driven regulation of the height of printing heads;
Substrata*	Printing on the majority of laminated matt and glossy surfaces, with the coat, based on water solution or without it; on cardboard, plastics, PVC and other coated materials;
Varnish on toner	Spot coating 3D directly on the most of digital prints without the need of laminating and coating;
UV coats and volume	Varnish is supplied from the container of 10-litre volume;
Automatic high-volume feeder	Feeder supporting piles of sheets of the height up to 30 cm; 2500 sheets with grammage of 135 g/m²;
Exit tray	Feeder supporting the pile of sheets up to 15 cm or ca. 1250 paper sheets with grammage of 135 g/m² and all formats of paper from A4 to 36.4 x 75 cm
Paper path	Paper path flat in 100%; Vacuum paper feeding system; Pneumatic feeding system; Automatic detection of double sheets; In-line LED dryer; Immediate drying and preservation during operation with the application of integrated LED lamps
Maintenance and remote technical support	Daily maintenance takes less than 10 minutes; Procedures are mostly automated; automatic cleaning system; From cold start-up to production during less than 15 minutes; Remote troubleshooting and support via internet camera (quick internet link is required)
Control panel	Integrated and user-friendly touch LED screen
Balance	± 1200 kg
Electric parameters	V: 220-240V 50-60Hz; A: 20; plug: 2 plugs CEE 17 IP44 32A (32A 250V, 1P+N+PE); RCD 30 mA; Switch-off 32A curve C
Working temperature	18 to 30°C; Relative environment humidity: 30-55% (without condensation);
Respect for the environment	Eliminates wastage of resources (electric energy, paper and varnish); Without films (offset) and screens (screen printing); Extreme reduction of the quantity of operating materials and utilization of bulk packaging; coating without volatile solvents
Options	Automatic converter of PDF files; Lighting AIS SmartScanner for metallised substrata

SOURCE: HTTPS://WWW.KONICAMINOLTA.PL/PL-PL/URZADZENIA/USZLACHETNIANIE/MGI-JETVARNISH-3D-ONE [2]

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TAB.2. TECHNICAL DATA OF DIGITAL MACHINE OF KONICA MINOLTA

Printing resolution	2400x3600 dpi x 8 bits
Format of sheet	Up to 1300 mm in two-side mode 900 mm
Speed of printing A4	120 pages/minute
Speed of printing A3	69 pages/minute

SOURCE: HTTPS://WWW.KONICAMINOLTA.PL/PL-PL/URZADZENIA/DRUK-PRODUKCYJNY/ACCURIOPRESS-C12000 [3]

TAB.3. TECHNICAL PARAMETERS OF DIGITAL MACHINE BY XEROX COMPANY

Printing resolution	2400 x 2400 dpi x 8 bits
Maximum format of sheet	330 x 480 mm
Minimum format of sheet	140 x 182 mm
Speed of printing	55-75 pages/minute

SOURCE: HTTPS://COPERONSALE.COM/WP-CONTENT/UPLOADS/BROCHURES/XEROX-770-DIGITAL-COLOR-PRESS-BROCHURE.PDF [4]

TAB.4. TECHNICAL DATA OF DIGITAL MACHINE BY CANON COMPANY

Printing resolution	2400 x 2400 dpi
Maximum format of sheet	330 x 1300 mm
Minimum format of sheet	182 x 182 mm
Speed of printing A4	90 pages/minute

SOURCE: HTTPS://PROXER.PL/OFERTA-DRUK/CANOC-IMAGEPRESS-C9010VP/ [5]

FIG.2. LAYER OF VARNISH ON NON-COATED BOX CARDBOARD

SOURCE: OWN PHOTO

FIG.3. WETTABILITY

SOURCE: OWN PHOTO

ImagePress C9010VP machine is a digital equipment of Canon company. It was used for printing of apla with the components of CMYK colour.

In table 4, the parameters of the mentioned device have been given.

VARNISHING OF NON-PRINTED SUBSTRATA

Initially, varnishing was performed on 3 different unprinted substrata; in the discussed study, the following box cardboards were employed: coated, non-coated and laminated soft touch materials. It was examined how varnish soaked in different substrata and visual assessment of the produced prints was carried out.

The non-coated cardboard has no additional coat which makes that the product is more stable and had no effect of gloss. Figures 2 – 4 represent the sample with a layer of varnish on uncoated box cardboard.

We may observe that the payer of varnish on the non-coated cardboard is least perceptible. When touching the surface, we feel the smallest difference between the substratum with varnish layer and that one without it. As far as visibility of the structure with different shapes is concerned, it is well visible for each element, even the smallest one. Depending on the type of the structure, varnish is less or more sensible in touch (palpable), however it is still in minimal degree.

In Fig 3, we may see a fragment where the wettability is read out. At value below 5 pixels, the lines become thinner and less distinct and at value of 1 pixel, they are invisible. It is evidence

FIG.4. PERCENTAGE COVERAGE WITH VARNISH

SOURCE: THE SAMPLE PERFORMED IN VARNISHING MACHINE BY KONICA MINOLTA

FIG.6. VARNISH LAYER ON UNCOATED PAPER

SOURCE: OWN PHOTO

that the application of layers with such small resolution is not possible on uncoated cardboard.

Figure 4 represents percentage coverage with a layer of varnish. It is commenced at 10% from the top and is ended at 100% in the bottom of the photo. In the case of 10% coverage, varnish is impalpable and practically invisible. Together with the increase in the percentage coverage, its tangibility by touch is increased. In the case of other substrata, the mentioned palpability is smaller, even at 100%. As far as the visibility is concerned when we look at the print, we do not perceive the layer of varnish until it is placed under the light; then we may see the presence of the discussed layer. It becomes well visible at coverage higher than 70%.

Figure 5 shows a fragment of layer with the text at the top: the text is covered with varnish; at the bottom, the surface around has been also coated with varnish. In the case of varnishing only the letters, even the smallest letters (size equal to 4 points) can be seen exactly and clearly. The image is readable and transparent. As far as surface is concerned, where the area around the letters was also coated with varnish, the visibility is good only for the letters of the size of 8 points and more. Below the mentioned size, the test becomes blurred, is less distinct and visible; in the case of 4 points, it is unreadable.

The coated paper is a type of paper with the additional coating which increases its aesthetic values, gives a smooth finish and reduces absorbance of printing ink. Figures 18-21 illustrate the sample with the layer of varnish applied on the mentioned paper.

In the case of coated box cardboard, varnish is visible on each layer and well palpable. We may feel the difference between the layer where varnish was applied and the site where it is absent. As far as the structure is concerned, it is exactly visible

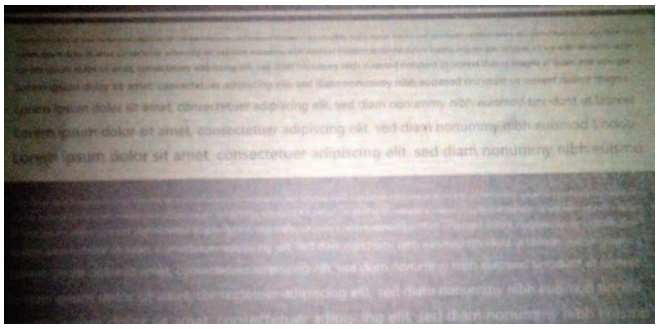

FIG.5. FRAGMENT WITH THE VARNISHED TEXT

SOURCE: OWN PHOTO

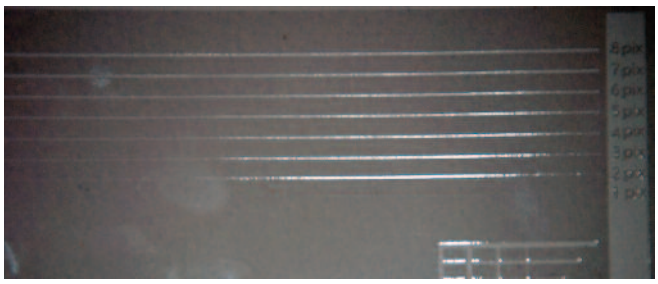

FIG.7. VISIBILITY OF POINTS DEPENDING ON THE RESOLUTION

SOURCE: OWN PHOTO

FIG.8. PERCENTAGE COVERAGE WITH VARNISH

SOURCE: OWN PHOTO

for all elements: the smooth ones and those with different, even the smallest designs. When touching them, we may distinctly feel the completely varnished, smooth surface and that one where the texture has a design (pattern). The irregular, rugged elements may be palpable.

FIG.10. VARNISH LAYER ON LAMINATED SOFT TOUCH CARDBOARD

SOURCE: OWN PHOTO

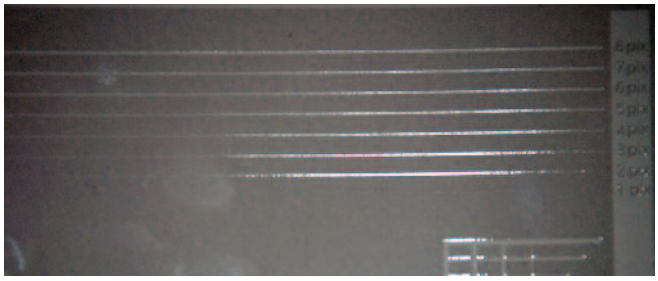

FIG.11. WETTABILITY

SOURCE: OWN PHOTO

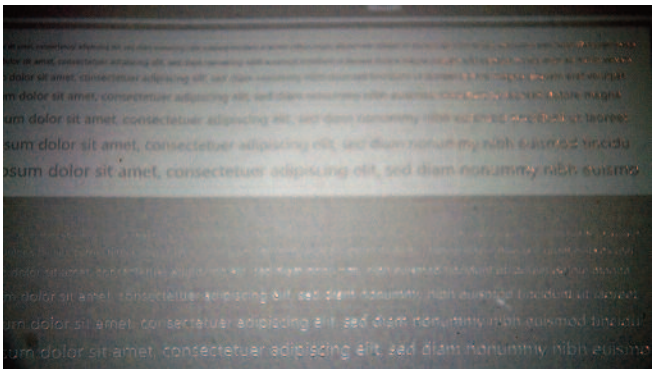

FIG.9. FRAGMENT WITH THE VARNISHED TEXT

SOURCE: OWN PHOTO

In a part of the segment, we may perceive the surface where the wettability is read out. The lines are visible up to the details with resolution of 2 pixels. The line of 1 pixel size stops to be visible. In the case of coated paper, the application of the layer with such small resolution is also not possible.

Together with the increase of the percentage coverage, the detection of varnish in touch of the surface is increased. On the areas with 10-30% coverage, varnish is invisible and the lighted elements have the non-uniform gloss. In the case of 40% coverage, we may see delicate scratches. Above 40% coverage, after each repeated application, the surface becomes smoother and at 100%, we may see the transparent tile.

In the case of the coated cardboard with the surface with varnish layer, all inscriptions are exactly and clearly visible only in letters, even those of the 4-point size. In the situation when the area around the inscriptions was also varnished, the visibility is weak. We can read the text of the size equal to 10 points but each smaller one is possible to read only when using a magnifying glass. For the letter of the size below 6 points, the read out, even with the magnification, is not possible. The inscriptions are unclear, as if the surface was spilled out.

The laminated sort touch cardboard was the last employed substratum. It is a substratum with the layer of laminated film soft touch (it is a matt foil) which makes that the cardboard becomes soft and delicate in touch. Figures 10-13 illustrate the substratum with the varnish layer.

In the case of coated cardboard, we do not feel greater difference in touch. The layer of varnish is well visible. The

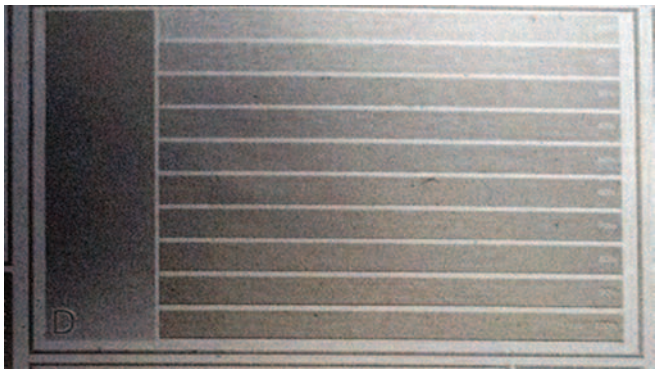

FIG.12. PERCENTAGE COVERAGE WITH VARNISH

SOURCE: OWN PHOTO

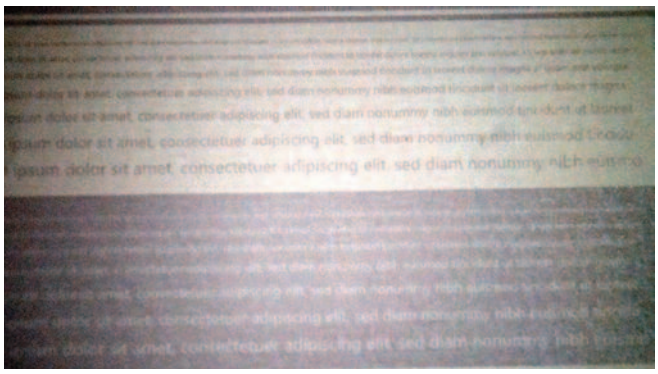

FIG.13. FRAGMENT WITH THE VARNISHED TEXT

SOURCE: OWN PHOTO

structure of the elements with irregular surface is also distinctly sensible in touch. However, in the places where the patterns with very small lines were employed, we have to look carefully at them in order to perceive the exact appearance of the surface. In the case of the mentioned substratum, the wettability is the best. We may see exactly all lines. Also, the line of 1 pixel resolution is visible.

In the case of box cardboard of soft touch type, the sensibility of varnish is increasing together with the increase of the percentage coverage of the surface. However, as early as at 10-% coverage, the layer is smooth and transparent.

The letters in size of 5-10 points are visible in the fragment where varnish was applied only on them. The text of 4-point size blends and it is not possible to read it out.

In the case of text where the layer of varnish was applied also around it, we may read the text at the size of letters equal to 8-10 points. We need, however, look at it carefully as the light is reflected from the layer and the text is spilled out.

SUMMING UP

The photos do not reflect precisely what may be seen in a direct contact with the samples. They were employed in order

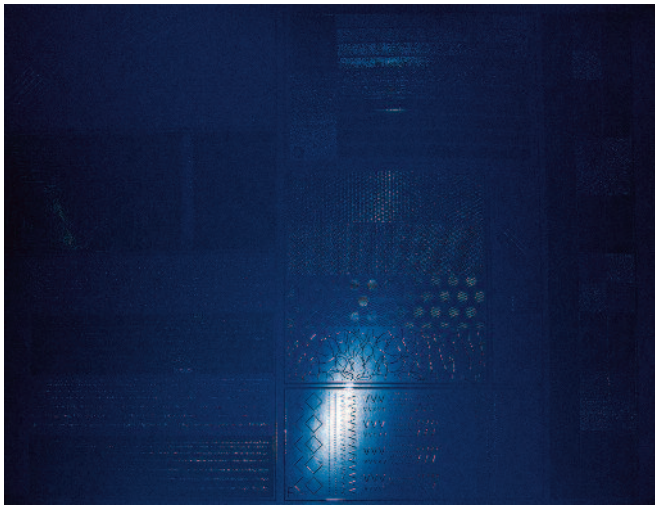

FIG.14. PHOTO OF THE SAMPLE WITH APLA IN CYAN COLOUR AND LAYER OF VARNISH

SOURCE: OWN PHOTO

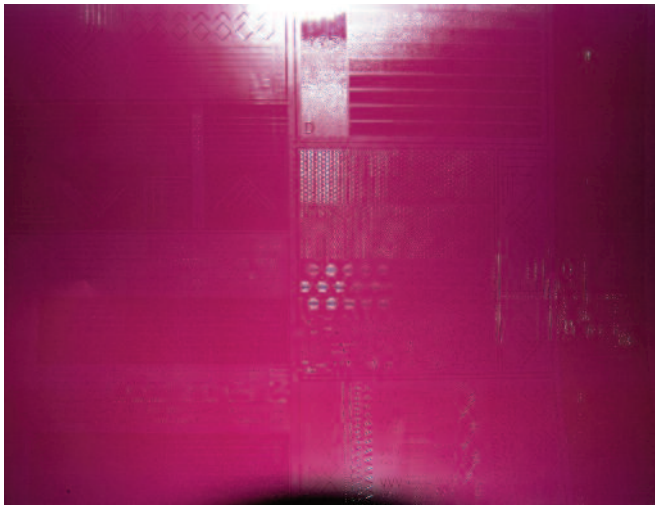

FIG.15. PHOTO OF THE SAMPLE WITH APLA IN MAGENTA COLOUR AND LAYER OF VARNISH

SOURCE: OWN PHOTO

to illustrate how the fields for reading out of different parameters of the samples look like.

In respect of adhesion, all box cardboards have a good ability to enter into combination with paper. The most optimal choice includes the choice of coated cardboard. We obtain then a good and clear structure but we may also successfully varnish the text without risk that it will become illegible. Good surface coverage is already visible at 40%.

SUBSTRATA WITH THE PRINTED CMYK LAYER AND VARNISH APPLIED SELECTIVELY

The test consisted in applying the layer of varnish on prints coming from digital machines by Konica Minolta, Canon and Xerox. On each machine, the printing of the complete apla was performed and the percentage composition was as follows:

C 25% M 25% Y 25% K 100%

C 0% M 0% Y 100% K 0%

C 0% M 100% Y 0% K 0%

C 100% M 0% Y 0% K 0%

Then, the layer of varnish was applied on earlier printed surface. Fig.14-17 represent the photos of the samples from 3 different machines.

In the present paper, the photographs of the samples with the best presentation of the effect obtained after varnishing on the surface of colour-printed substratum, have been demonstrated. The mentioned photographs do not however reflect the real appearance of the samples. They were printed with the layer of varnish of 21 μm thick (it is the optimum layer of varnish applied on the substratum of this type). After the analysis of the research material, it may be stated that after applying of the varnish layer on coated cardboard which is printed, the visibility of the image is the worst. Varnish spreads out the most.

In touch, each sample is identical. The structure of different applied layers is also the same for each colour and from each machine. As far as the visibility of details is concerned, they are best visible in aplas with cyan and black colour. It is most difficult to perceive the details on the samples printed with yellow colour.

We may see the differences in percentage coverage depending on the printing machine. The prints coming from equipment of Canon and Xerox have a smooth surface already at 70% whereas for prints deriving from Konica Minolta machine, the smooth surface is visible as late as in the vicinity of 90% coverage of the surface. It should be mentioned that Canon and Xerox machines are used in manufacturing conditions whereas Konica Minolta equipment is a basic machine, being used only sporadically.

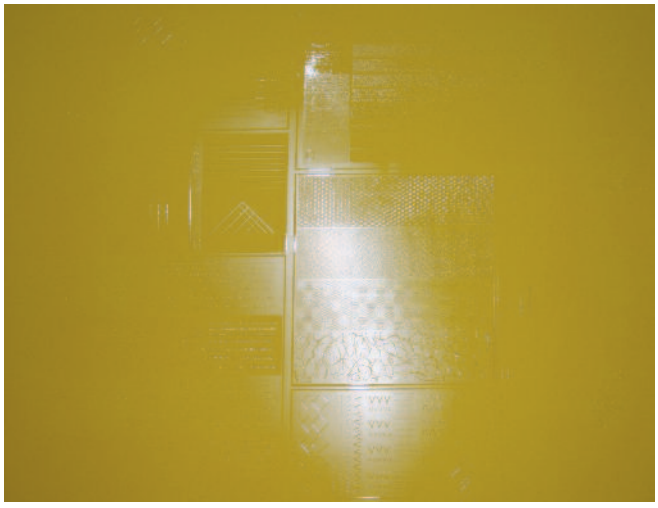

FIG.16. PHOTO OF THE SAMPLE WITH APLA IN MAGENTA COLOUR AND LAYER OF VARNISH

SOURCE: OWN PHOTO

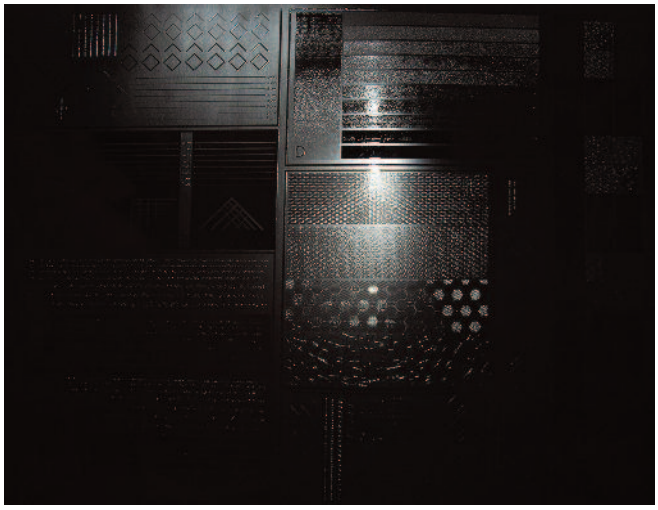

FIG.17. PHOTO OF THE SAMPLE WITH APLA IN MAGENTA COLOUR AND LAYER OF VARNISH

SOURCE: OWN PHOTO

As compared to unprinted coated paper, the difference in wettability is visible; on the paper without print, the spot with the resolution of 1 pixel was not visible and on the samples covered with the ink, it was distinct and readable.

It should be added that the photos made for work purposes were performed with the use of the same camera, at the same settings, from the same perspective and at the same light. In spite of this fact, the way of reflecting the light depending on the colour and type of the employed machine was different. It could be caused by the fact that each machine has toners with somewhat different composition so they could reflect the light in a different way.

FINAL CONCLUSIONS

Machine, with the use of which varnishing was carried out, contains piezoelectric heads with DoD system (drop on demand), which sprinkles the surface what facilitates spot application of varnish. The employed solution enables application of thicker layer of varnish what allows obtaining convex and 3D effect. In effect, we may obtain more interesting sensible and visual impressions.

In the present research tests, the layer of varnish of 21 μm was applied. It is the thickness employed in order to obtain 3D effect; the thicker layer should be even applied. The smallest details would be then visible and different structures would be sensible. In the case of non-coated cardboard, to obtain the result similar as on the coated substratum, we should increase the thickness of the varnish layer so as remain its greater part of the substratum surface and not allow its soaking into the mentioned substratum. It does not however guarantee the success as the non-coated cardboards are not intended for prints with the refining layer due to the differences in surface tension between substratum and varnish. In the case of soft touch cardboard where the touch effects were well sensible, but the visibility was the worst one, it should be necessary to use thinner layer of varnish; then, the visibility would be smaller but the chance that the visibility might be improved could take place and the effect of spreading out would not exist.

Printing of coated substratum with colour made that the spots with 1 pixel resolution which were not visible on the coated unprinted paper became visible. On the mentioned prints, varnish was most spreading out and the visibility was limited. We should, however, pay attention that they were the samples where a specified colour was applied in 100% on one of them. During the implementation of the discussed order of the customers, it rather will not occur that it will be necessary to use one componential colour on the total surface and cover it with varnish. Mixing of the colour and post application could improve visibility. We should however remember about the correct choice of the thickness of varnish and analyse how great the varnished surface should be as to give the best result. When varnishing the fragments such as letters or unprinted surface, the texture of which we intend to change (owing to varnish), we may obtain interesting effects which will affect the visual impressions of the consumer [6, 7].

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REVIEWED ARTICLE

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COMPOSTABILITY OF DECORATIVE PAPER TISSUE NAPKINS

KOMPOSTOWALNOŚĆ PAPIEROWYCH SERWETEK DEKORACYJNYCH NA PODŁOŻU TISSUE

ABSTRACT: When choosing the products, consumers pay more and more attention to ecology. The environmental protection begins to play a meaningful role in everyday life. Ecology means not only the produced materials intended or suitable for recycling but also the increase of the interest in reusable products and innovations such as compostable materials. The market is aiming at ecological solutions, utilizing the alternative natural materials and being adapter to the financial possibilities of the customers.
Key words: compostability, biodegradability, eco-toxicity

STRESZCZENIE: Konsumenci wybierając produkty coraz większą rolę przypisują ekologii. Ochrona środowiska zaczyna odgrywać istotne znaczenie w codziennym życiu. Ekologia oznacza nie tylko materiały wykonane czy nadające się do recyclingu, ale również wzrost zainteresowania produktami wielokrotnego użytku oraz innowacjami takimi jak materiały kompostowalne. Rynek zmierza w kierunku rozwiązań ekologicznych, wykorzystujących alternatywne materiały naturalne i dostosowanych do portfela klienta.
Słowa kluczowe: kompostowalność, biodegradowalność, ekotoksyczność

INTRODUCTION

When summing the year 2023 in packaging sector, the paper industry portal juxtaposes two words: economy and ecology. The consumers play more and more attention to ecology aspects and the producers seek for the solutions which would optimize the budget. The market evolves towards ecological solutions. 75% of Poles ascribe a significant role to environment protection in everyday life; moreover, ecology means the increase of interest in reusable products and also, the innovations such as compostable materials [9]. The decorative paper napkins are not a packaging as the play, first of all, a decorative function. We use them for the decoration of tables during parties and ceremonies; for wiping our hands and mouth, we place also cakes on them and wrap foods for a short period of time. In connection with the above, they are subjected to many legal regulations which concern the products in contact with food. At the same, after use, they become the waste which should be managed. Therefore, the compostability is the solution which may contribute to the reduction of the quantity of mixed waste.

THE BASIC REQUIREMENTS CONCERNING COMPOSTABILITY

Compostability is a capacity of biodegrading of the material in compost environment in effect of which humus (natural fertilizer) is generated. Material is defined as compostable when, as a result of its decomposition in the environment, any eco-toxic substances are not generated. Moreover, biodegradation products must undergo disintegration into fraction of undistinguishable size in finished compost; they cannot also affect negatively the quality of compost [6]. If the compost is to become the substrate for plant cultivation, the content of eventual toxic degradation products (inter alia, heavy metals, polychlorinated biphenyls or dioxins) in the emerging compost cannot exceed the level admitted by standards [4].

The assessment of the suitability for composting is carried out on the grounds of PN-EN 13432:2002 Packaging Requirements for packaging recoverable through composting and degradation – Test scheme and evaluation criteria for the final acceptance of packaging[1]. The introduced European standard is harmonized with Directive 94/62/EC of the European Parliament and of the Council of 20 December 1994 on packaging and packaging waste. Directive 94/62 EC supports in particular, the development of the European standards relating to:

- criteria and methodologies for life-cycle analysis of packaging,
- the methods for measuring and verifying the presence of heavy metals and other dangerous substances in the packaging and their release into the environment from packaging for appropriate types of packaging,
- criteria for recycling methods,
- criteria for composting methods and produced compost,
- criteria for the marking of packaging.

PN-EN 13432:2002 together with other standards may be employed for confirmation that the packaging, as intended for introduction into the market, satisfies the principal requirements, as laid down in Directive 94/62/EC. The basic functions of packaging include storage and protection of products and facilitation of transport and presentation of the product. The organic recovery of post-use packaging is one of a few methods of recovery which end the life cycle of packaging. In order to save the natural resources and minimize the amount of the waste, it is recommended to optimize the whole system, connected with the packaging. The mentioned optimization includes preventing the generation of the waste as well as multi-use and also, recovery of packaging waste.

The evaluation of the suitability of packaging and its elements for biological treatment should cover at least the following 5 procedures:

- characteristics of material,
- biodegradability,
- disintegration, including the products of biological treatment
- quality of compost,
- identification of materials, what means that they should be recognized as compostable and biodegradable by final users.

Characteristics of material means that each considered material should be identified and characterized before tests, at least in the following way:

- supply of information on the components of packaging materials and their identification,
- indication of the presence of dangerous substances, e.g. heavy metals

TAB.1. MAXIMUM CONTENT OF ELEMENTS IN PACKAGING MATERIAL AND IN THE WHOLE PACKAGING

SOURCE: PN-EN 13432:2002

Element	mg/kg of dry matter	Element	mg/kg of dry matter
Zn	150	Cr	50
Cu	50	Mo	1
Ni	25	Se	0,75
Cd	0,5	As	5
Pb	50	F	100
Hg	0,5		

1 The present standard is translation of English version of European standard EN 13432:2002 Packaging Requirements for packaging recoverable through composting and degradation – Test scheme and evaluation criteria for the final acceptance of packaging

– determination of the content of organic carbon, dry matter and volatile constituents in packaging materials, used in biodegradability and disintegration tests.

In the case of heavy metals and other toxic and dangerous substances, their maximum levels have been determined; their content should not exceed values, given in Table 1.

It has been adopted that biodegradability should be determined for each material or its significant organic component; the significant organic component is considered as each organic component the content of which exceeds 1% of dry matter of material. On the other hand, the total participation of organic components, without determination of their biodegradability, should not exceed 5%. The tests of biodegradation are carried out in aerobic conditions; the time of the tests should amount to maximum 6 months. The biodegradation expressed in percentage for the tested material should be equal to at least 90% of the whole or 90% of maximum degradation of the respective reference substance after reaching the optimum level for the tested material and the reference substance. For the composting process lasting maximum 12 weeks, it is required that no more than 10% of dry matter of the tested material is remained on the sieve of the mesh size equal to 2 mm.

To meet the requirement of eco-toxicity, the indicator of the sprouted seeds and the increase of vegetal mass for two species, as conducted on the samples of the tested compost, should constitute more than 90% in relation to reference compost.

CERTIFICATION OF COMPOSTABILITY ON THE EXAMPLE OF DECORATIVE PAPER NAPKINS, PRODUCED IN PRINTING PLANT POL-MAK SP. Z O.O.[2]

Tissue paper is a basic raw material for production of decorative paper napkins[3]. In connection with the fact that POL-MAK Iława is producer of the tissue paper, obtaining of certificate which would confirm the compostability of napkins included, first of all, conducting the studies of compostability of tissue paper. The tests were outsourced to one of the laboratories, indicated by the certifying body. The test consisted of three parts:

– determination of the content of heavy metals;
– biodegradability;
– eco-toxicity.

In the first stage of the tests, the following results of the determination of heavy metal contents, as given in Table 2, were carried out. The heavy metals, as identified in the sample, are found within the limits indicated by PN-EN 13342:2002.

The next stage covered test of degradation. The degradation test under the defined composting conditions at the pilot scale is a standardized process of composting. The experimental material (decreased to dimensions: 10 cm x 10 cm for film and 5 cm x 5cm for the remaining products) is mixed in a precise concentration with the fresh bio-waste and is introduced to a defined composting environment; then, the process of biological composting is spontaneously commenced. The natural, universally present population of microorganisms begins the process of composting. The compost mass is regularly turned over and mixed. Temperature, pH, humidity

[2] Printing Plant POL-MAK was founded in 1986. Owing to confidence of the Customers it has been a leader on the national and foreign market of decorative paper products. As being a family company, it takes care – for the whole time – of the consequent and thoughtful development. The products, from the beginning up to the end, are manufactured in Poland. They are characterized by a high quality, carefully selected raw materials and refinements. The napkins, dishes, cups, bags and gift papers accompany the Customer in the most important moments of their life, generating the family and solemn atmosphere; they allow spending wonderful moments with the family and friends. The qualified employees are extremely important element of the company's development. Skills and involvement of the workers facilitate offer of wider and wider spectrum of the products of the world quality. Pol-Mak is striving at observation of social and environmental standards in the whole supply chain, from obtaining of raw material until the supply of final user. The company has made the obligation to implement the sustainable development and bear the responsibility for economic, social and ecological effects of production.

[3] The concepts of paper and cardboard are not univocal and they are often confused. One of the most popular classifications is based on paper density (unitary weight). The employed terminology is also differentiated according to the country and even producers. Polish paper industry uses sometimes also customary classification according to which paper products are classified into tissue paper (up to 28 g/m2), paper (from 28 g/m2 to 160 g/m2), paperboard (from 160 g/m2 to 315 g/m2) and cardboard - above 315 g/m2 [3]. Due to not very precise definitions and lack of univocal nomenclature during purchase-sale transactions, paper weigh as well as format are usually used and the terminology is an intuition question.

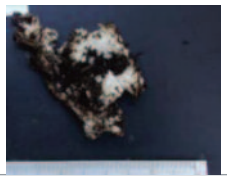
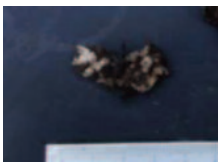
TAB.2. HEAVY METALS' CONTENT – THE RESULTS OF ANALYSES

SOURCE: REPORT FROM THE TESTS CONDUCTED IN OUTSOURCED LABORATORY

Chemical element	Value mg/kg (dry matter)	Chemical element	Value mg/kg (dry matter)
Zn	2.09±0.82 50	Cr	0.80±0.24
Cu	0.56±0.17	Mo	0.051±0.029
Ni	1.04±0.31	Se	n.d.
Cd	n.d.	As	n.d.
Pb	0.073±0,019	F	n.d.
Hg	n.d.		

TAB.3. PARAMETERS AND VISUAL OBSERVATIONS

SOURCE: REPORT FROM THE TESTS CONDUCTED IN OUTSOURCED LABORATORY

Week	pH	Moisture % (w/w)	O2 %	Observation of color, erosion, consistency and odour	Picture (The pictures are illustrative and not representative of the whole specimens)
Start					
2	8.6	51.0	>10%	The specimens show change in color and structure.	
4	8.6	45.3	>10%	The disintegration process begin.	
6	8.8	48.0	>10%	All the specimens are broken.	
8	8.3	46.7	>10%	The pieces are decreasing in size.	
10	8.1	46.1	>10%	Small pieces are still distinguishable from the compost	---
14	7.9	49.3	>10%	No pieces are still distinguishable from the compost	---
18	7.9	47.7	>10%	No pieces are still distinguishable from the compost	---
180 days	7.5	45.6	>10%	No pieces are distinguishable from the compost even after the sieving procedures	---

and composition of gas in the compost material are regularly monitored and they must satisfy the defined requirements as to ensure the sufficient and appropriate microbiological activity. The process of composting is carried on until the moment of obtaining the completely stabilized compost (after 180 days). The results of degradation are given in Table 3. At the end of the composting process, the mixture of compost and test material is filtrated on sieve with the meshes of 2 and 10 mm. If possible, the balance of mass is calculated on the grounds of wet and dry matter content. Compost obtained at the end of composting process may be used for further measurements such as chemical analyses and tests of eco-toxicity.

Test of eco-toxicity is commenced from the preparation of test soils. Plastic utensils (tray for the seeds) containing minimum 200 g of each compost (reference soil, test mixtures and blank sample) were filled and at the top, 100 seeds were laid on directly after preparation of the test mixture or up to 24h later. The seeds were not soaked before their planting and were covered with a thin layer of neutral material. The tests were carried out in three repetition of each mixture. Water was added until obtaining 70-100% of water content. Gradually, depending on the needs, the evaporated water was periodically added during the whole period of the test. During the sprouting stage, the trays were kept in darkness. The conditions of the test were similar to those indispensable for a normal growth of the tested species and varieties. The pots were placed in a room with a controlled temperature and humidity; the temperature was controlled via ventilation, heating and/or cooling systems. During the test, the following conditions were employed:

- temperature: 22°C±3°C,
- humidity: 60%±10%,
- photoperiod: minimum 16h of light,
- light intensity: 7000 lux

The trays for the seeds were periodically changed to minimize the variation of the plant growth (due to the differences in the test conditions in the cultivation objects).

During the observation period, 14 days after emergence of 50% of the control plants, the plants were observed in aspect of occurrence of visual phytotoxicity and mortality. In the 14th day of the test, a part of the test plants was randomly selected and the following final parameters were measured:

- number and percentage of plant emergence as compared to the blank compost;
- fresh mass (biomass);
- visible detrimental effects for different parts of the plants.

FIG.1. EXAMPLES OF MARKING THE COMPOSTABLE PRODUCTS

SOURCE: PROJECTS OF POL-MAK

The rate of germination and biomass were expressed as a percentage of the respective values, obtained for the blank compost. In connection with the fact that the tests showed that the rate of germination and biomass had exceeded the specification indicated by EN 13432:2002, it was adopted that any negative effect on germination and growth of the tested plants was not observed.

The above mentioned tests confirmed the suitability of tissue paper for composting.

For printing of napkins, based on paper tissue, the flexographic water-based inks are employed. To have the final product certified, all the raw materials, used in production, should be certified. In connection with this fact, the certified inks should be used in production within the limits consistent with the certificate possessed by ink producer. When having the certified raw materials, there were obtained the products which were subjected to certification. In effect of the certification process, the mentioned products are compliant with the requirements of EN 13432:2002 concerning the compostable products. Paper napkins which meet the requirements of compostability are market by the producer with logo ok compost (Fig.1)

CONCLUSIONS

The market of compostable materials in Poland has currently the innovative and niche character but, at the same time, perspective one. When striving at its development, we should undertake the innovative ventures to respond to activators and supporting factors as well as problems and barriers. The consumers become to understand the meaning of procedure consistent with the spirit of ecological thinking; marking of the products will serve this purpose. Many consumers, as being convinced about the easy biodegradability of materials, marked with the appropriate sign, will throw them away to home composters or even simply throw them away as they think that in natural environment they will be subjected to quick and harmless degradation. The basic difference between the compostable and biodegradable materials consists in the fact that the compostable products require the special conditions to be degraded whereas the biodegradable products are degraded in a natural way. Composting is usually the quicker process but it requires controlled conditions (appropriate humidity and temperature and oxygen presence). On the other hand, lack of coherent program of management of the waste coming from compostable materials, in connection with the lack of the appropriate education of the society in this respect and the non-univocal system of marking the packaging intended for composting may lead to discourage of the consumers from the appropriate segregation of the mentioned materials. Moreover, the discussed problem includes also lack of uniform and transparent regulations concerning planning and organization of closed economy of compostable packaging. The lack of the consumers' awareness of the significance of the packaging problem, lack of education (e.g. in schools and social media) and information campaigns concerning bio-packaging (including compostable packaging), or e.g. deficit of mobile applications, supporting the popularization of knowledge on the waste segregation as well as lack of sufficient financial stimuli, supporting the activity in this respect at the level of self-governing bodies may lead to a lack f perspectives for development of compostable materials [1, 5, 8]

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THE PAPER PACKAGING REVOLUTION: A SHIFT TOWARDS SUSTAINABILITY AND INNOVATION

The packaging industry is poised for a transformative shift in the coming decade, particularly in the area of paper-based packaging. This shift is driven by a growing movement against plastic packaging and the recognition of its environmental impact. Governments and brands are actively pushing for change through legislation and innovative packaging solutions. This article will briefly look into the leading role that brands and innovative technology companies are playing in promoting sustainability through the adoption of paper packaging alternatives.

BRANDS TAKING THE LEAD

Major brands are proactively seeking sustainable alternatives and spearheading the shift towards paper-based packaging. Absolut Vodka for example, recently announced a trial of a paper-based bottle for its flagship vodka product as part of their dedication to a more sustainable future. The Global Director of Future Packaging at Absolut, Elin Furelid, cited high recycling rates and the appealing tactile nature of paper as key factors behind their decision. According to TheSpiritsBusiness.com, in line with Absolut's goals, the brand proudly announces its

The packaging industry stands on the brink of a major transformation, with paper packaging emerging as a leading alternative to plastic and glass

PIC. ARCHIPELAGO POWERDROP™

trajectory towards becoming a carbon-neutral product by 2030. Impressively, Absolut's distillery emits a staggering 98% fewer emissions compared to the industry average, solidifying its position as a leader in sustainable practices.

Another example is Diageo, a prominent drinks maker, who has partnered with Pilot Lite to establish Pulpex, a UK-based paper bottle company who continuously strive to redefine the boundaries of sustainable packaging. Pulpex creates customized paper bottles suitable for various liquid products, and Diageo plans to package Johnnie Walker whisky in Pulpex bottles. According to Diageo, these thoughtfully designed containers, actively contribute to Diageo's commitment to Goal 12 of the United Nations Sustainable Development Goals, focusing on fostering 'Responsible Consumption and Production'. Renowned brands such as PepsiCo, Unilever, and Castrol have also joined forces with Pulpex to develop paper bottle solutions for their iconic products. This product is empowering brands to reimagine packaging designs without compromising on versatility and quality.

Overall, these examples show that leading food and drinks brands are embracing paper packaging on a large scale. Mars announced its trial of Mars bars wrapped in paper, moving away from traditional plastic wrappers. Nestle, on the other hand, has developed a high-speed flow wrap line to package Kit-Kats in paper. Brands are driving innovation in the development of paper packaging solutions. They are investing in research and development to create packaging materials that are both sustainable and functional. Through collaboration with packaging manufacturers, they are pushing the boundaries of what is possible with paper packaging, exploring advanced technologies and techniques to enhance its durability, resistance to moisture, and other desirable characteristics.

Archipelago Technology, an influential player in packaging coating, has responded to the growing demand for sustainable packaging solutions by introducing a game-changing innovation. Their non-contact coating machine uses PowerdropTM technology - a large-scale inkjet printing system

The packaging industry will undergo transformation in the coming decade, especially in the area of paper packaging. Large companies activelyare looking for sustainable alternatives and are leading the shift towards paper packaging

that jets viscous liquids as droplets with precision and consistency. Powerdrop can jet sticky glue-like coatings that other technologies, such as spray, struggle with. Importantly every drop goes just where it's meant to and nowhere else. Powerdrop enables packaging manufacturers to coat rigid paper containers making them waterproof while keeping the inner paper core clean, so it can be recycled. Because Powerdrop uses highly concentrated coating fluids and has virtually no overspray there are major savings in energy use and overspray disposal, this gives it low running costs and low greenhouse gas emissions. Powerdrop can help save thousands of tonnes of CO2 on a single production line, while addressing the longstanding challenge of maintaining the structural integrity of paper containers when exposed to liquids, presenting a viable and eco-friendly substitute for single-use plastic plates, bowls, cups and bottles.

With immense potential in this market, we can expect a rapid influx of further innovations aimed at meeting the demand for sustainable paper packaging alternatives some of which we will hopefully be able to see showcased at drupa 2024.

The shift from plastic and glass to paper packaging holds numerous advantages for various stakeholders. Consumers stand to benefit from the shift to paper packaging in several ways. Firstly, paper packaging aligns with their increasing demand for eco-friendly products and packaging. By choosing brands that prioritise sustainability, consumers can make environmentally responsible choices and contribute to a greener future. Additionally, paper packaging often has a tactile and aesthetic appeal that enhances the overall product experience. It can provide a premium, natural, and rustic feel that resonates with consumers seeking a more authentic and organic image. Furthermore, paper packaging is lightweight and easy to handle, making it convenient for consumers to carry and dispose of responsibly.

Retailers can leverage the popularity of paper packaging to enhance their eco-friendly image and appeal to environmentally conscious shoppers. By offering products in paper packaging, retailers can differentiate themselves from competitors and attract a growing market segment of conscious consumers. This can lead to increased footfall, higher sales, and improved customer loyalty. Additionally, retailers can collaborate with brands that prioritise sustainability and reinforce their commitment to environmental responsibility, further strengthening their brand image and market positioning.

Within the supply chain, the adoption of paper packaging creates opportunities for innovation and growth throughout. Packaging manufacturers, paper suppliers, and other stakeholders can collaborate to develop new technologies and solutions that cater to the demand for sustainable packaging. This shift stimulates the development of a circular economy, where materials are recycled, reducing waste and minimizing environmental impact.

Brands that embrace paper packaging can enhance their image and reputation by positioning themselves as environmentally responsible and forward-thinking. Sustainability is a growing concern for consumers, and brands that prioritise sustainable practices often enjoy increased customer loyalty and positive brand perception. By adopting paper packaging, brands demonstrate their commitment to reducing plastic waste and their efforts to contribute to a greener future. This can result in improved brand equity, customer trust, and a competitive advantage in the market.

Governments worldwide are implementing stricter regulations on plastic packaging, creating a regulatory landscape that incentivises the adoption of sustainable alternatives. By proactively embracing paper-based packaging, brands can ensure compliance with evolving legislation and reduce the risk of fines or penalties. This proactive approach can enhance brand reputation and demonstrate a commitment to social and environmental responsibility.

The packaging industry stands on the brink of a major transformation, with paper packaging emerging as a leading alternative to plastic and glass. Notable brands across the food and drinks sectors are at the forefront of this shift, recognising the importance of sustainability and seizing the opportunity to meet consumer demands. By embracing paper packaging, these companies not only contribute to a cleaner environment but also benefit from increased consumer loyalty, improved brand image, and compliance with evolving regulations. As the next 10 years unfold, the paper packaging revolution promises significant growth, innovation, and a more sustainable future for the industry as a whole. The collaborative efforts of brands, retailers, and policymakers are key to driving this revolution forward, ultimately paving the way for a greener and more sustainable world.

WARSAW PACK: THOUSANDS OF VISITORS AND HUNDREDS OF CONTRACTS

On April 23-25th, 2024, the Ptak Warsaw Expo exhibition centre became an international contracting platform for the packaging and packaging technology sector. This is due to the Warsaw Pack trade fair, the ninth edition of which placed emphasis on networking and industry education.

The packaging industry is one of those undergoing the most dynamic changes. In 2024, it is reaping the benefits of economic recovery after a temporary stagnation in the previous period. At the same time, it is being affected by a number of trends, especially those related to ecology. There is a growing emphasis on increasing the share of biodegradable, compostable packaging and packaging made from renewable materials. Every year Poland positions itself among the European leaders in this sector, so it was important to integrate national experts on the way to further development of the industry. This was served by the ninth edition of Warsaw Pack, which took place on April 23-25th, 2024 at Ptak Warsaw Expo.

EXPERT DISCUSSIONS AND KNOWLEDGE TRANSFER

During the event, visitors could take advantage of as many as four educational panels led by the most respected experts and practitioners in the industry. In cooperation with the Polish Chamber of Packaging and Łukasiewicz – Lodz Institute of Technology, a conference "Innovation in packaging – regulations, ecology, digitalization" was organized. During it, the state and market prospects of the packaging industry in 2024 were analysed, the latest legal regulations – plastic tax, PPWR, deposit system – were discussed, and safety and quality management in relation to the requirements for food and cosmetics packaging manufacturers were covered. Marcin

Dubownik from Łukasiewicz – Lodz Institute of Technology gave a lecture on "Cups and disposable packaging: between technological challenges and sustainable circular practice," Konrad Sulak spoke about sensory packaging based on biopolymers, and Waldemar Galikowski talked about product and packaging labelling while minimizing costs in the enterprise. However, this was not the end of education during Warsaw Pack. Participants could also benefit from the conference "The Evolution of Packaging: digitalization, artificial intelligence and EU regulations as an industry driver," organized by Ptak Warsaw Expo in cooperation with Creative Packaging Group. During this event, the packaging law in the European Union was presented, 2D code marking was discussed, and the role of artificial intelligence in the sector was highlighted. In addition, Krzysztof Kondziela from Turck Sp. z o.o. gave a lecture on "Digitalization as a tool for increasing the efficiency and reliability of production." What's more, together with Marcin Zieliński (Promark SA.), Wojciech Siwek (Automatec Sp. z o.o.), Dr. Radoslaw Maruszkin (Maruszkin Law Firm) and Radoslaw Dylewski (WAY TO AI Sp. z o.o.) took part in a thematic panel discussion moderated by Malgorzata Chomiuk.

On the same day, there was also a panel on "Packaging in a closed loop – what future awaits the industry?", during which the current situation in the packaging and packaging waste management market was analysed, PPRW was presented as a new reality of the packaging industry, and planned changes in PL and EU law regarding marking on packaging were signalled. However, there were many more topics discussed.

On the last day of Warsaw Pack, attendees were able to take part in the Exhibitor Presentations and Trends panel. It included five lectures: "Flintec: products, application and dynamic weighing" (Arkadiusz Sumowski, Tomasz Kupicha), "2D code marking - extraordinary opportunities for production, logistics and marketing" (Mariusz Parypiński), "Current changes and legal requirements for food and cosmetics packaging" (Adam Fotek), "What can go wrong? That is, risk and safety management in freight transportation" (Tomasz Magoń), and '2D code marking - extraordinary opportunities for production, logistics and marketing' (Mariusz Parypiński). The educational agenda structured in this way allowed all Warsaw Pack participants to enrich and update their knowledge.

SEVERAL THOUSAND VISITORS AND INDUSTRY LEADERS AT WARSAW PACK

In addition to education, Warsaw Pack served largely for networking, exchanging business information and acquiring valuable leads. The effectiveness of the industry integration is evidenced by hundreds of new contracting agreements and the establishment of business acquaintances to grow in the sector.

The ninth edition of the event was attended by 23,884 investment-ready sector representatives, who learned about the offers of 511 exhibitors from 43 European countries.

The latter included Ocean Systems, HG Robotics, Bosky, Premacy, Pod Polska, IMA, Chiorino, Food Pack, RBECO, THT, Rolls, Spolex, Filmat, Pakowarka, Fenix Systems, Weindich, Lukasiewicz, Green Tree, POLPAK, Pablo, AGJ, Intrex or AWM PAK.

THE SUCCESS OF THE NINTH EDITION OF WARSAW PACK HAS TRANSLATED INTO THE ORGANIZATION OF THE NEXT EDITION OF THE EVENT WHICH WILL BE HELD ON APRIL 8-10, 2025 AT PTAK WARSAW EXPO

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