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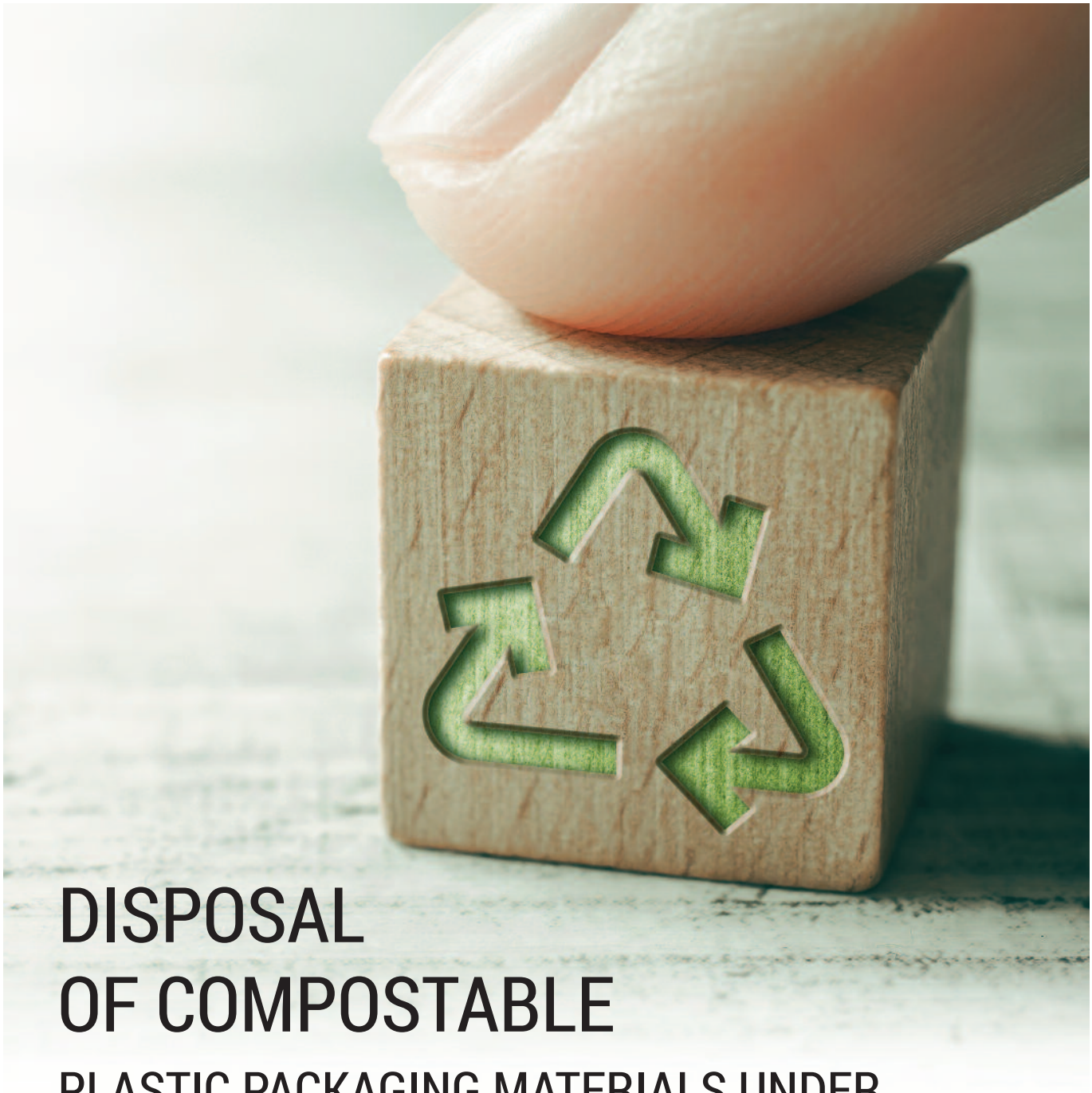

DISPOSAL OF COMPOSTABLE PLASTIC PACKAGING MATERIALS UNDER CONTROLLED INDUSTRIAL CONDITIONS

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Dear Readers!

Reducing the disposal of packaging waste and promoting a more circular economy are the current challenges of modern global economy. The Circular Economy Action Plan for a cleaner and more competitive Europe concerns the entire life cycle of products, from design and manufacturing to consumption, repair, reuse, recycling, and bringing resources back into the economy. Some plastic packaging items could be compostable under industrially controlled conditions in bio-waste treatment facilities. I strongly encourage you to read the article on pages 20-24. that reviews and discusses studies on industrial composting carried out at the composting plant in Zabrze of selected biodegradable polymeric materials in terms of life cycle assessment (LCA).

In "Packaging Review" 2/23 you will also find a review of bioplastic packaging as well as an interesting article on growing popularity of fanfold corrugated board.

Enjoy your reading!

Anna Naruszko, M.Sc. Graduate of the Institute of Printing at Warsaw University of Technology (currently the Department of Printing Technologies, Faculty of Mechanical and Industrial Engineering, Warsaw University of Technology). Editor-in-chief of the monthly trade magazines "Poligrafika" and "Opakowanie", CEO of Alfa-Print Sp. z o.o, publisher of these magazines and of the scientific quarterly "Packaging Review".

Drodzy Czytelnicy!

Ograniczenie ilości odpadów opakowaniowych i promowanie gospodarki o obiegu zamkniętym to aktualne wyzwania nowoczesnej gospodarki w Europie i na świecie. Plan działania dotyczący gospodarki o obiegu zamkniętym na rzecz czystszej i bardziej konkurencyjnej Europy dotyczy całego cyklu życia produktów, od projektowania i produkcji po konsumpcję, naprawę, ponowne użycie, recykling i ponowne wprowadzanie zasobów do gospodarki. Niektóre opakowania z tworzyw sztucznych mogą nadawać się do kompostowania w warunkach kontrolowanych przemysłowo w zakładach przetwarzania bioodpadów. Polecam zatem Państwa uwadze artykuł na stronach 20-24, omawiający badania dotyczące kompostowania przemysłowego. Przeprowadzono je na kompostowni w Zabrzu dla wybranych biodegradowalnych materiałów polimerowych z punktu widzenia analizy cyklu życia (LCA).

W Packaging Review 2/23 znajdziecie Państwo również opracowanie na temat opakowań z biotworzyw oraz interesujący artykuł na temat rosnącej popularności tektury falistej bez końca.

Ciekawej lektury!

Mgr inż. Anna Naruszko. Absolwentka Instytutu Poligrafii Politechniki Warszawskiej (obecnie Zakład Technologii Poligraficznych, Wydział Mechaniczny Technologiczny PW). Redaktor naczelna miesięczników branżowych „Poligrafika" i „Opakowanie", prezes zarządu Alfa-Print Sp. z o. o, wydawcy tych miesięczników oraz kwartalnika „Packaging Review".

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REVIEWED ARTICLE

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ENDLESS CORRUGATED CARDBOARD (FANFOLD): PRODUCTION AND APPLICATION

TEKTURA FALISTA BEZ KOŃCA (FANFOLD): PRODUKCJA, ZASTOSOWANIE

ABSTRACT: The increase of demand on corrugated board boxes is connected with a sudden increase of the number of persons who decide on the on-line purchase of goods. It is expected that FMCG sector will be the main generator of incomes for the producers of corrugated board boxes. It is anticipated that the growing demand on packaging in different sectors and boom in the e-commerce in the coming years will create the profitable possibilities of the solutions, employing corrugated cardboard packaging of fanfold type.
Key words: corrugated board, fanfold, corrugator, feeder, box production

STRESZCZENIE: Wzrost popytu na pudła z tektury falistej jest związany z gwałtownym wzrostem liczby osób decydujących się na zakupy online. Oczekuje się, że branża FMCG będzie głównym generatorem przychodów dla producentów pudeł z tektury falistej. Przewiduje się, że rosnące zapotrzebowanie na opakowania w różnych branżach i boom w handlu elektronicznym stworzą w nadchodzących latach lukratywne możliwości dla rozwiązań z tektury falistej typu fanfold.
Słowa kluczowe: tektura falista, fanfold, tekturnica, podajnik, produkcja pudeł

Fanfold is a continuous band of corrugated board, creased and folded in harmonica (concertinaed), being also called z-fold, z-cardboard or folding (other English determinations include: endless board and continuous corrugated). The folded corrugated board is a profitable solution, enabling consumption of smaller quantity of material and reduction of material reserves. The fanfold is automatically folded according to the preliminarily set programme during production of corrugated cardboard. At the beginning, the discussed type of cardboard was mainly used in production of packaging in the furniture-producing industry. Due to the fact that the application of the corrugated cardboard in the continuously folded band (fanfold) as opposed to the stack of the sheets of corrugated cardboard increases the flexibility of production; it may be used for manufacture of packaging for the products with different dimensions and in different quantities, so it is the ideal current solution in the production of the so-called "packaging on demand".

Due to the mentioned above reason, the level of the market of the corrugated cardboard of fanfold type is continuously increasing. In 2021, it was estimated at 28.61 billion USD dollars and it is anticipated that it will increase up to 39.86 billion USD dollars in 2030, i.e. the anticipated CAGR (CAGR, Compound Annual Growth Rate) gain in the years 2022-2030 will amount to 3.7% [1]. The increase of demand on corrugated board boxes is connected with a sudden increase of the number of persons who decide on the on-line purchase of goods. It is expected that FMCG sector (abbreviation of Fast Moving Consumer Goods) will be the main generator of incomes for the producers of corrugated board boxes. It is anticipated that the growing demand on packaging in different sectors and boom in the e-commerce in the coming years will create the profitable possibilities of the solutions, employing corrugated cardboard packaging of fanfold type [1].

The advantage includes also the ecological character of the discussed packaging material as it by its nature, is suitable for

recycling. The fanfold board may be produced in different widths (from 300 to 2800 mm), it may be three-layer or five-layer cardboard. Owing to this fact, the fanfold is the optimum solution in the case of the application of enormous quantity of packaging materials in different dimensions and specifications. Specificity of production of fanfold corrugated board. In manufacture of the corrugated board of fanfold type, we may utilize a new or already existing corrugator which should contain a special built-in stacker of fanfold in which the band of the corrugated board will be first creased and then, stacked. There are automatic as well as semi-automatic (the operator supports manually the process of stacking) systems of creasing and stacking the fanfold cardboard. The disadvantage of the manual support includes, first of all, a relatively low speed as well as a low quality of stacking. The maximum rate in the case of automatic stacking is 150-200 m/min. The example of such automated system for stacking of cardboard may be the solution, developed at BHS Corrugated; it has been presented in the paper: "Modern driving systems in corrugator" [3]. The mentioned solution enabled the parallel production of board in a form of sheet manufacture and in a form of continuously folded band (fanfold). The speed of the manufacturing line may reach 200 m/min and the change of the forms may occur at the rate of 70 m/min [3]. The production speed will be determined by such parameters as the number of bands, produced in parallel, their width, the length of the forms between creasing, and the type and properties of the employed paper. The automatic stacker consists of the following subunits (Fig.2):

FIG.1. FANFOLD CORRUGATED BOARD BY RONDO.

HTTPS://ISSUU.COM/RONDOGANAHL/DOCS/ENDLOSWP_EN

SOURCE: ENDLESS POSSIBILITIES.

- creaser of the cardboard,
- folding unit,
- cutting and separating unit, and
- lifting table and evacuation.

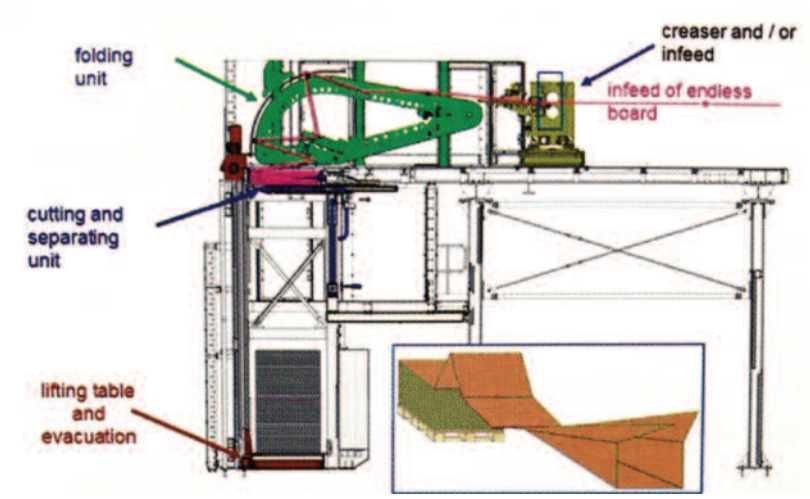

FIG.2. THE SCHEME OF AUTOMATIC STACKER OF FANFOLD BOARD. SOURCE: MUSIELAK S.K., KASPRZYK J.G. MODERN DRIVING SYSTEMS IN CORRUGATOR. PAPER REVIEW NO 6 (69), 2013, PAGE 367. HTTPS://SILO.TIPS/DOWNLOAD/NOWOCZESNE-SYSTEMY-NAPEDOWE-W-TEKTURNICY

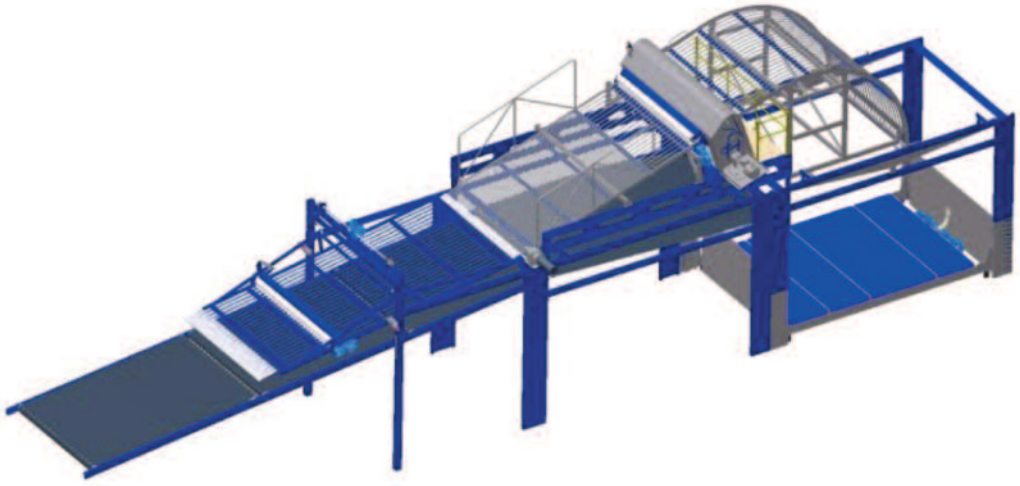

FIG.3. SYSTEM OF FANFOLD CORRUGATED CARDBOARD STACKER BY UNIVERSAL CORRUGATED B.B.

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In September 2020, BHS Corrugated took over the company Universal Corrugated B.V. The latter company is known for the development of the system of automatic stacker Unifold for corrugated cardboard of fanfold type (Fig.3) and has a big experience in respect of non-standard solutions for the customers. Owing to this fact, it has a very good position at the market. By this, Universal and BHS Corrugated will be able to develop optimally and independently the discussed growing segment of the market and define independently the main areas of activities. As it was given in the press information [4], the task of the Universal team will be to focus, first of all, on design, development, installation, starting up and maintenance of the stacker systems for fanfold corrugated cardboard. The plans will also include the development of special individual solutions for stacking the corrugated board and production of equipment for manufacture of the board of "honeycomb" type [4, 5].

The supplementation of the corrugator with the stacker system for production of continuous fanfold board will allow the producers of corrugated board to master the manufacture of a new product which is currently dynamically developing.

Production of boxes based on the continuous corrugated board (fanfold). The presence of the corrugated (two- and five-layer) fanfold board enabled the passage to the conception of producing the packaging being completely fit to the product – the packaging tailored to the dimensions (Fit-to-Product, FtP).

The appropriate machines were introduced and they facilitated production of boxes made from fanfold board; the mentioned equipment implemented, in general, the following operations:

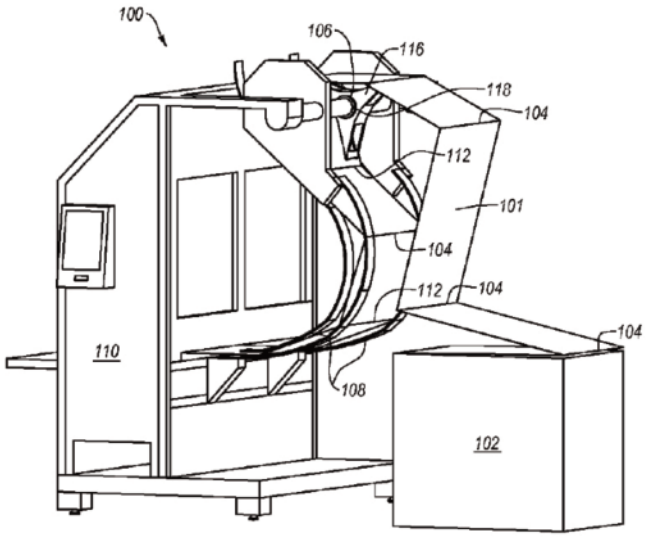
- cutting the fanfold band;
- performance of the box pattern (creasing, performance of slots, cutting out the "hands" etc);
- laying the glue;
- printing in one cycle.

Machines/equipment intended for production of boxes from fanfold board differ in respect of the automation degree, yield and the range of the performed operations. They may be fed with one stream of fanfold cardboard (Fig.4a) as well as with a few streams (Fig. 4b, 5 and 6). The multi-stream feeding gives the possibility of more optimal selection of the width of the corrugated board band for a specified dimension of flap box. The developed control software plays an important role in planning and implementation of the whole manufacturing process of packaging. In the case of multi-stream feeding, it enables – based on the graphic form of the pattern (in digital form) – the choice of optimum width of the band from which the packaging will be produced, with the minimum quantity of wastes. It facilitates also the process of optimization at the stage of coordination and management of the process of manufacture of single packaging as well as of the series of

packaging and the most complicated and demanding flows of operations connected with the production of packaging made from corrugated board. It accelerates the manufacturing process, allowing the company to dispatch more quickly the orders to the customers.

Two recent market reports, developed by Market Reports World i.e. "Box Making Machines Market 2022 Industry Price Trend, Size Estimation, Industry Outlook, Business Growth, Report Latest Research, Business Analysis and Forecast 2028 Analysis Research" [6] and by Transparency Market Research, entitled "Corrugated Box Making Machine Market – Global Industry Analysis, Size, Share, Growth, Trends and Forecast 2020 – 2030. Corrugated Box Making Machine Market" [7] contain the list of leading producers of equipment and machines for production of corrugated board boxes. The mentioned list is as follows: Bobst Group SA (Switzerland), EMBA Machinery AB (Sweden), Fosber S.p.a.(Italy), Box on Demand (Panotec, Italy), LCR Group (Italy), KOLBUS GmbH & Co. KG (Germany), Packsize International (USA), Serpa Packaging Solutions (USA), Spark Technologies (The Netherlands), Zemat Technology Group Ltd (Poland), ISOWA Corporation (Japan), Shinko Machine <FG. Co. Ltd (Japan), Saro Packaging Machine Industrie (Mano Industrial Machine Tools, India), ACME Machinery Co. Pvt. Ltd (India),

A)



B)

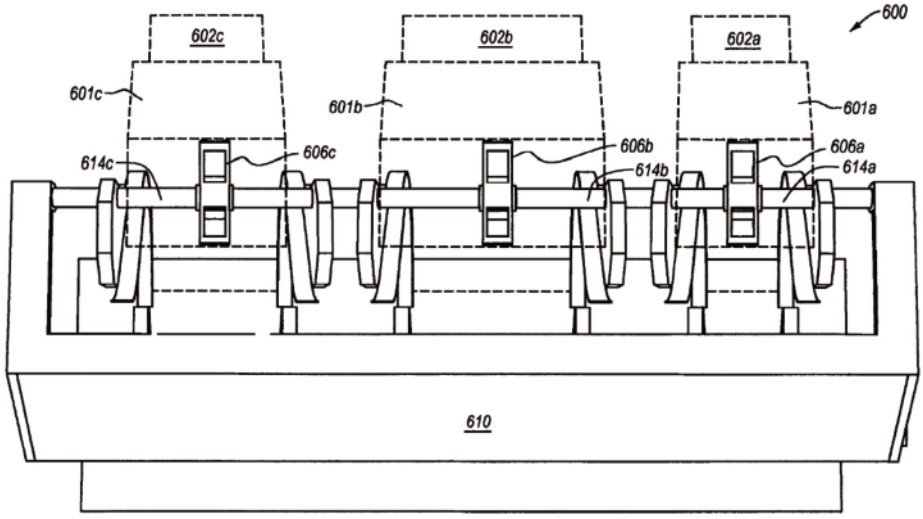


FIG.4. SINGLE (A) AND MULTI-STREAM (B) FEEDING WITH FANFOLD BOARD, AS DEVELOPED BY PACKSIZE COMPANY. US PATENT WO2010091043A1. INFEED SYSTEM. WO2010091043A1. NIKLAS PETTERSSON, PACKSIZE LL C.

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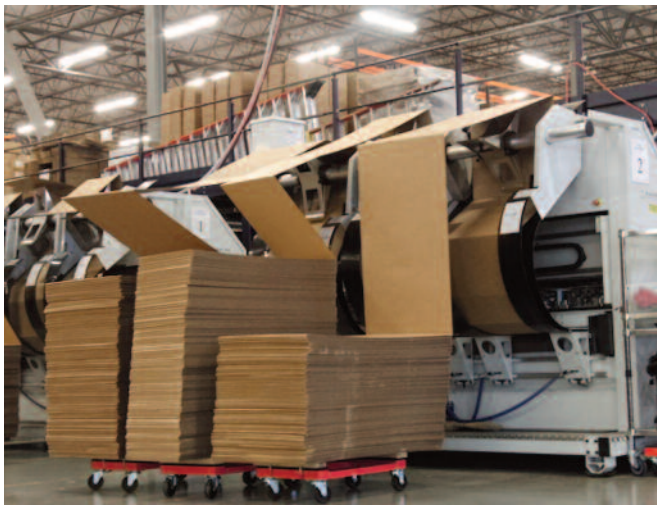

FIG. 5. MULTI-STREAM FEEDING OF FANFOLD BOARD IN PACKSIZE EQUIPMENT

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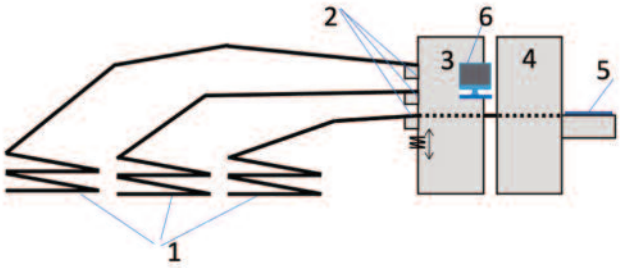

FIG. 6. THE SCHEME OF BOXMAT FANFOLD EQUIPMENT BY ZEMAT COMPANY, AS BEING FED WITH THREE STREAMS OF FANFOLD BOARD:
1 – THREE STACKS OF THE FOLDED BAND OF FANFOLD TYPE;
2 – THREE MOBILE CASSETTES OF FEEDING MODULE;
3 – FEEDING MODULE; 4 – CUTTING-SLOTTING-CREASING MODULE;
5 – PATTERN (FORM) OF THE BOX; 6 – CONTROL SOFTWARE.

SOURCE: OWN ELABORATION.

Shanghai Print Young International Industry (China), Shengli Carton Equipment Manufacturing (China), Wenzhou Zhongke Packaging Machinery Co. Ltd (China) [6-8]. A part from the mentioned above companies is producing the equipment which have the possibility of working with multi-stream fanfold cardboard feeders, for example, Packsize International, Box on Demand, LCR Group, Spark Technologies and Polish company Zemat Technology Group.

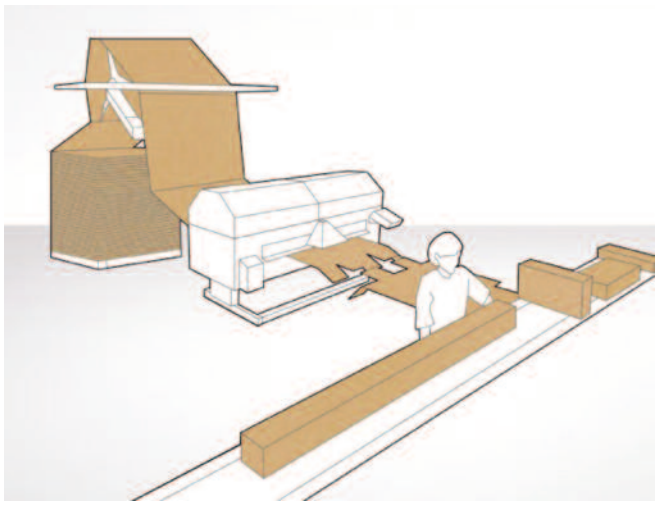

FIG. 7. INTEGRATION OF MACHINE FOR PRODUCTION OF FANFOLD CORRUGATED BOARD BOXES AND PACKAGING LINE. ENDLESS POSSIBILITIES. FANFOLD CORRUGATED BOARD BY RONDO.

HTTPS://ISSUU.COM/RONDOGANAHL/DOCS/ENDLOSWP_EN

Irrespectively of the method for packaging the products, i.e.: manual packaging, packaging by a simple machine, or a complex packaging line, fanfold corrugated board works perfectly in a wide spectrum of packaging processes (Fig.7). In the case of packaging of great quantities of products, the application of specifically designed machines/lines gives a great potential. The mentioned machines give big possibilities of the development in e-commerce sector and may be combined with the packaging line what allows the reduction of costs of packaging the products and acceleration of the whole cycle. The worldwide innovative system of automatic packaging CVP-500 by Neopost Shipping from Drachten (The Netherlands), as being installed in Poland, may the example of the discussed possibilities [9]. The principle of functioning of the mentioned system consists in the following operations:

– the packed product or a few products are placed on the transmission belt;
– scanner 3D of CVP-500 system determines the dimensions of the product/products intended to be packed and the information is sent to the box-manufacturing machine;
– the fanfold cardboard is automatically taken from the feeder. Then, the dispatch box is produced and its dimension is ideally fit to the contents;
– the label is printed and adhered to the box.

The product packed into the discussed box is ready to dispatch. The application of automatic packaging system reduces considerably the costs of the work at the packaging stands (it may replace even up to 10 persons). It also eliminates completely the necessity of using the additional fillers in the boxes as the dimensions of the produced box are fit to the product which is packed in.

THE ADVANTAGES OF THE PACKAGING PRODUCED FROM FANFOLD CORRUGATED BOARD

The main advantages of employing the fanfold board in combination with the machines and lines for manufacture of fanfold corrugated board boxes include:

- a reduced consumption of material – owing to the choice of optimum width of the corrugated board band in relation to the specified dimension of the box;
- the reduced consumption of material – elimination of the necessity of adjusting the additional filling materials in the packaging that is not fit to the size of the product;
- reduction of the negative effect on the environment due to the minimization of raw material wastes in a form of corrugated board;
- saving of storage area: fanfold replaces many individual forms of corrugated board sheets;
- smaller consumption of corrugated board during packaging of the products; in such case, the size of packaging is adjusted to the product alone, there is no "empty" space to be occupied;
- a simplified process of administration of storage, management of reserves and ordering;
- the possibility of better utilization of the existing infrastructure owing to dimensional production of the boxes. Greater quantity of boxes may be places of the truck, on transporter or at every stage of the supply chain.

The fanfold corrugated board conquers the market of raw materials and packaging owing to its competitive advantages. At the very beginning of the application of fanfold corrugated board, it was employed for packaging of the products with big dimensions (furniture); to-day, the range of the application of the fanfold corrugated board is very wide; they are used in production of packaging of furniture, car parts, electronic products, different consumption good and industrial products and in e-commerce.

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REVIEWED ARTICLE

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DISPOSAL OF COMPOSTABLE PLASTIC PACKAGING MATERIALS UNDER CONTROLLED INDUSTRIAL CONDITIONS IN VIEW OF LIFE CYCLE ASSESSMENT

UTYLIZACJA NADAJĄCYCH SIĘ DO KOMPOSTOWANIA PLASTIKOWYCH MATERIAŁÓW OPAKOWANIOWYCH W KONTROLOWANYCH WARUNKACH PRZEMYSŁOWYCH Z PUNKTU WIDZENIA ANALIZY CYKLU ŻYCIA

ABSTRACT: Reducing the disposal of packaging waste and promoting a more circular economy are the current challenges of modern global economy. The Circular Economy Action Plan for a cleaner and more competitive Europe concerns the entire life cycle of products, from design and manufacturing to consumption, repair, reuse, recycling, and bringing resources back into the economy. Some plastic packaging items could be compostable under industrially controlled conditions in bio-waste treatment facilities. The article reviews and discusses previous studies on industrial composting carried out at the composting plant in Zabrze of selected biodegradable polymeric materials in terms of life cycle assessment (LCA).
Key words: waste management, recycling, (bio)degradable polymers, industrial composting, LCA

STRESZCZENIE: Ograniczenie ilości odpadów opakowaniowych i promowanie gospodarki o obiegu zamkniętym to aktualne wyzwania nowoczesnej gospodarki w Europie i na świecie. Plan działania dotyczący gospodarki o obiegu zamkniętym na rzecz czystszej i bardziej konkurencyjnej Europy dotyczy całego cyklu życia produktów, od projektowania i produkcji po konsumpcję, naprawę, ponowne użycie, recykling i ponowne wprowadzanie zasobów do gospodarki. Niektóre opakowania z tworzyw sztucznych mogą nadawać się do kompostowania w warunkach kontrolowanych przemysłowo w zakładach przetwarzania bioodpadów. W tym artykule dokonano przeglądu i omówiono wcześniejsze badania dotyczące kompostowania przemysłowego prowadzonego na kompostowni w Zabrzu wybranych biodegradowalnych materiałów polimerowych z punktu widzenia analizy cyklu życia (LCA).
Słowa kluczowe: gospodarka odpadami, recykling, polimery (bio)degradowalne, kompostowanie przemysłowe, LCA

INTRODUCTION

Every year around 2 billion tons of solid waste are produced in the world. According to experts' predictions, in just 30 years, we can expect the production of waste at the level of 3.4 billion tons per year. This drastic increase will pose a major challenge to waste management in the context of the entire planet. It is therefore worth thinking now about how we can reduce the production of waste as much as possible. The end-of-life options, used in waste management, include reuse, energy recovery (incineration) and recycling. The recycling is the intentional action that aims to reduce the amount of waste deposited in landfills by industrial apply of this waste to obtain raw materials or use of waste as a full-valuable materials for further processing (chemical or mechanical recycling). What's important, the recycling are recommended waste treatment option fit to the circular economy model. [1-3]

THE WASTE MANAGEMENT IN PRACTICE

According to the circular economy the existing resources should be rationally use, minimize waste and try to keep the using items in circulation as long as possible. It was the last of the postulates mentioned that was the inspiration for the creation of the Reuse Point in Zabrze. Such facilities have been operating in many countries for a long time, now also in Poland (Figure 1).

In this place everyday objects such as furniture, books or toys, which for some have already lost their value get a new life and in accordance with the principles of circular economy return to reuse in a new form.

Presently the "green", ecological production of chemical products and modern technologies, taking into account aspects related to the natural environment are widely implemented by different manufacturer of industrial chemicals, for example PCC Group Company. PCC Group offers a new chemical products in the PCC Greenline® segment, also manufactured from recycled raw materials and bear the "Production based on recycled materials" mark. An examples may be adhesives designed for bonding styrene-butadiene rubber (SBR) granulates obtained from the recycled car tires, as well as adhesives for rebond foam produced from ground mattresses.

FIGURE 1. REUSE POINT - BACK2LIVE, AT THE POINT OF SELECTIVE COLLECTION OF MUNICIPAL WASTE (PSZOK)

(FROM HTTPS://WWW.FCC-GROUP.EU/PL/POLSKA/AKTUALNOSCI.HTML)

However, technologies limiting the production of waste aimed at their processing and further use require specialized production processes, raw materials, additives and chemicals. [4] The use of renewable resources for the production of biodegradable polymeric materials and the production of goods based on them, combined with the process of their composting after fulfilling their intended utility functions, is a unique opportunity to adjust the life cycle of this type of materials to the natural cycle of matter. Such a life cycle cannot be achieved with conventional plastics. [2]

Taking into account the biowaste, the organic recycling (composting and anaerobic digestion) are used. The polymeric materials and the final products made of them are considered as susceptible to composting if they meet the EN 13432:2000 standard, i.e. they are biodegradable in at least 90% in less than 180 days [5]. Biodegradable packaging intended for composting should have a special mark and be collected together with organic waste. Organic biowaste generated in households should be separated from the municipal waste stream. The excellent solution in the case of home collecting organic waste are the compostable bags. Whereas, the selective collection systems implemented in many European countries are mainly based on special containers with appropriate colors (Figure 2). [6]

FIGURE 2. CONTAINERS FOR WASTE SEGREGATION

FIGURE 3. THE BASKET WITH TESTED SAMPLES AND COMPOST

THE ORGANIC RECYCLING

Packaging and packaging materials suitable for composting and treatment under anaerobic conditions show the ability to biodegradation and disintegration during test, and the products of this process do not have a negative impact on the quality of the obtained compost. The (bio)degradation of polyesters occurs as a result of the action of specific enzymes or by the hydrolysis of ester bonds, and most often both of these mechanisms occur in the appropriate sequence. Thus, the mechanism of the biodegradation process is complex, involving many chemical and biological reactions. The final products of this process are: biomass (organic matter), water and gases – carbon dioxide (CO_2) for aerobic, methane (CH_4) for anaerobic conditions. [7,8]

In the field of biodegradable materials, aliphatic polyesters currently produced on a commercial scale: polylactide (PLA) and polyhydroxyalkanoates (PHAs), as well as aliphatic-aromatic polyesters of the Ecoflex® type and their polymeric blends are of particular interest. The composting tests were also performed for final products in form of market bags as well composite items [9-12], Table 1.

TESTS UNDER INDUSTRIAL COMPOSTING CONDITIONS

At the Centre of Polymer and Carbon Materials, Polish Academy of Sciences (CMPW PAN) a systematic research under industrial composting conditions are conducted, based on developed methodology for polymeric materials. Samples tested were putted in racks at specially designed stainless steel baskets with dimensions of 27 x 70 x 21 cm (width x length x height, see Figure 3).

The baskets with samples were placed in the tested environment: in a compost pile, a KNEER system container or in one of the BIODEGMA system module at a depth of 0.5-1 m below the compost surface and incubated for a specified time are performed at the municipal waste disposal premise in Zabrze, Poland. [13-17]

In the studies the final products such as rigid films, food storage trays made of polylactide type PLA2002D and its polymeric blends with synthetic poly([*R*,*S*]-3-hydroxybutyrate) (aPHB), obtained by ring-opening polymerization (ROP) of β-butyrolactone (β-BL) were used. Whereas, the prototype cosmetic containers were produced by 3D printing from a commercial PLA/PHA filament from ColorFabb containing 12% PHA. [18,19] Research was also carried out for materials with a higher degree of processing. During the incubation of the samples, the characteristic parameters of the tested environments were monitored, and the current weather conditions were obtained from the Provincial Inspectorate for Environmental Protection. After appropriate incubation times (depending on the type of composting system), subsequent samples were withdrawn from the degradation environment. After each collection, the samples were cleaned in distilled water and then dried to constant mass at ambient temperature.

TABLE 1. LIST OF TESTED MATERIALS WITH REFERENCES

Type of polymer	Description of materials tested	Ref.
poly(*D,L*-lactide) (PDLLA)	PDLLA contain 12 mol% of *D*-lactide, a commercial product of GALACTIC Company, monofilament with thickness of 1 mm obtained using a laboratory single-screw extruder	[24]
poly(*L*-lactide) (PLLA)	monofilament produced as described above	
poly(1,4-butylene adipate-*co*-1,4-butylene terephthalate) (Ecoflex®, PBAT)	commercial product of BASF Company, monofilament produced as described above	
Ecoflex®	monofilament produced as described above	[25]
PBAT, PDLLA	monofilament of blend PBAT/PDLLA (70/30) produced as described above	
PBAT, PDLLA	monofilament of blend PBAT/PDLLA (90/10) produced as described above	
PBAT, PDLLA, synthetic analogue of natural poly([*R*]-3-hydroxybutyrate) (PHB) – poly([*R,S*]-3-hydroxy butyrate) (aPHB)	monofilament of blend PBAT/PDLLA/aPHB (90/5/5) produced as described above	
PDLLA, aPHB	multilayer packaging materials produce from paper and one layer of blend PDLLA/aPHB (90/10)	[26]
PDLLA, aPHB, poly(vinyl alcohol) (PVA)	multilayer packaging materials produce from paper and two layers of PDLLA/aPHB (90/10) blend and PVA	
poly(ε-caprolactone) (Solvay, ε-PCL), aPHB	multilayer packaging materials produce from paper and one layer of blend ε-PCL/aPHB (90/10)	
Solvay, aPHB, PVA	multilayer packaging materials produce from paper and two layers of ε-PCL/aPHB (90/10) blend and PVA	
PVA	multilayer packaging materials produce from paper and one layer of PVA	
polylactide (PLA), PBAT	commercial biodegradable bags (CONS-PET and Bio Planeta) contain polylactide (13 and 20%), and commercial additives	[16]
polylactide	commercial product (NatureWorks LLC, US, type 2002D, with 3.5% of *D*-mers content). was reprocessed 0, 1, 2 and 3-times in a co-rotating twin screw extruder	[23]
polylactide, aPHB	commercial product (NatureWorks LLC, US, type 2002D, with 3.5% of *D*-mers content) and blend with 15 mol% of synthetic aPHB, the samples were prepared in the form of rigid films with the average thickness of 0.3 mm on the test stand for extrusion of flat film	[20], [21]
polylactide	rigid packaging (trays) obtained from vacuum thermoformed films on a stand with a negative form	[22]
Ecovio® F Mulch C2311	blend of PBAT with 12 mol% PLA, a commercial product of BASF company, in the form of a dumbbell--shaped (thickness of 1.5 mm) or film with thickness of 80 μm as a prototype of the cosmetic packaging	[17]
polyethylene (PE) contained commercial totally degradable plastics additives (TDPA)	commercial shopping bag from a Polish supermarket labeled as an "ECO bag – bag that undergoes 100% biodegradation in 12 months"	[9]
ε-PCL type CAPA™ 6800 (Solvay)	composites of crosslinking ε-PCL with flax fibers	[11]
PLA, PBAT	blends of PBAT and PLA, containing 17 and 40 mol% of PLA in form of film (thickness of 0.02 mm), and 40 mol% of PLA in form of disposable bag type market, prepared by Bioerg Company (thickness of 0.1 mm), by means of the extrusion process on a test stand to extrusion of conventional flat film using a single-screw extruder	[10]
PLA, polyhydroxyalkanoate (PHA)	prototype of cosmetic containers in the form of jars obtained from commercial PLA and PLA/PHA blend 3D printing filaments using fused deposition modeling printer	[19]
polylactide	composites of polylactide type 2003D (Cargill Dow LLC, Minnetonka, MN, USA, with 4% of *D*-lactic acid) containing 0.5, 5 and 10 wt% of coffee, cocoa or cinnamon extracts	[12]
poly(3-hydroxybutyrate-*co*-4-hydroxybutyrate) (P3HB4HB, Sogreen00A)	P3HB4HB and its composites with cork in form of 1BA test specimen were prepared using the micro-extruder MiniLab	[13]

FIGURE 4. DIGITAL PHOTOGRAPHS OF THE THERMOFORMED FINAL PRODUCT FROM PLA RIGID FILM BEFORE AND AFTER 1, 2 AND 3 WEEKS OF DEGRADATION IN A KNEER SYSTEM CONTAINER

The degradation progress of the tested polymeric materials was followed by determining changes in their average molar masses and dispersion with use gel permeation chromatography method (GPC). In addition, composition and thermal properties were also monitored, as well as macroscopic and microscopic changes in the surface of the samples were observed (Figure 4).

Results on the biodegradation process are presented in a series of publications. [13-27] The incubation process of the multi-reprocessing materials was carried out in a composting pile at an average temperature of 61 ºC and an average pH of 7.0. The impact of processing (as the recycling model) on the disintegration of the tested samples was found. The disintegration of materials with a higher degree of processing, above 3 cycles of passage through the extruder, was found already in the first week of incubation in the composting pile. The samples processed 1, 2 and 3 times, disintegrated only after 6 weeks of incubation, which was not found after 3 weeks of this process (Figure 5). [23]

In recent years, the biodegradable packaging industry has seen an increase in interest in the use of composites of biodegradable polymers with natural fibers that meet the directions of activities in accordance with the principle of sustainable development. The challenges related to the design of polymer biocomposites that are stable during use, as well as susceptible to attack by microorganisms during organic recycling, are still current. The current research focuses on the application of the developed research methodology to assess the impact of the content of fillers in composites and other additives on the composting process of the polymer matrix. [12,13]

The obtained results indicated that in selected environment of industrial composting the hydrolytic degradation via random ester bond scission, like to it occur under abiotic conditions, is preferentially. However, the observed progressive decrease in pH of sterile extract (SE) of industrial compost at invariable pH of the nonsterile extract (NSE) indicates that microbes present in compost can assimilate the products of abiotic hydrolysis of the incubated samples [20]. Moreover, the differences observed in the degradation rate of final products (bags) of Bioerg Company with a similar content of the PLA component could be suggest the influence of materials thickness or the commercial additives used during processing on degradation profile under industrial composting condition. For example the presence of talc may interfere with materials behavior towards water and consequently the course of biodegradation changes [10].

Studies of the industrial composting process were also carried out for an oxo-degradable bags offered previously in markets. It was found that their disintegration occur longer than 6 months, therefore these materials should not be labeled as compostable. The slow degradation and fragmentation is probably due of partially crosslinking after long time of

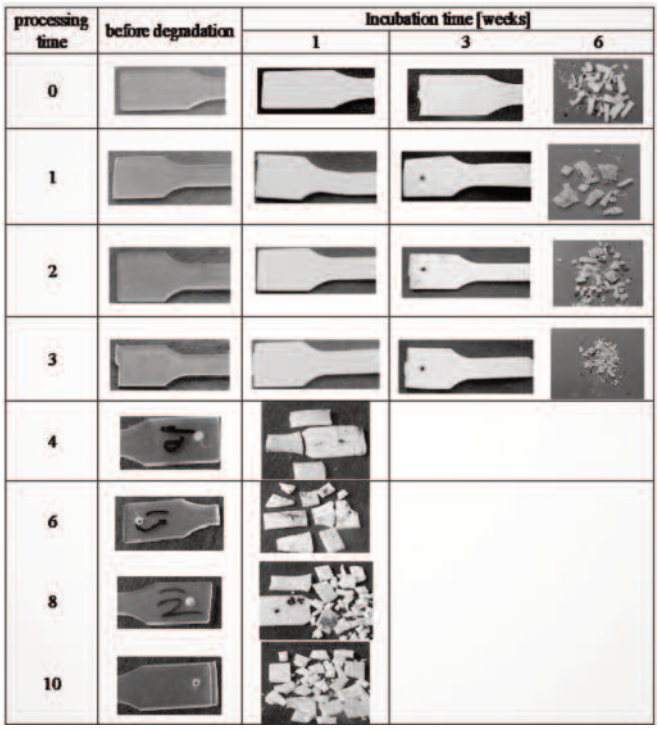

FIGURE 5. DIGITAL IMAGES OF THE PROCESSING SAMPLES BEFORE AND AFTER INCUBATION

degradation, which results in the limitation of low molar mass residues for assimilation [9].

INDUSTRIAL COMPOSTING IN TERMS OF LCA

Compostable plastic materials are still in the early stages of development and occupy a small market niche. Their further development is related to the improvement of properties, availability and lowering the price, as well share the municipal organic waste collection systems [28]. In order to assess the environmental impact of the composting process, the life cycle assessment (LCA) methodology can be applied to the municipal waste stream generated. According to the ISO 14040 standard, the life cycle is defined as "successive and interrelated stages of a product, from obtaining or producing a raw material from natural resources to its final disposal". The application of LCA is carried out through a step-by-step procedure, and it involves four main phases: i) goal and scope definition, ii) life cycle inventory (LCI), iii) life cycle impact assessment (LCIA), and iv) interpretation and improvement [29, 30]. The LCI phase is one of the most critical phases since it deals with data collection to map all the input and output flows (i.e., material and energy consumptions, emissions, waste) characterizing the system under study. The application of LCA allows for the evaluation of the environmental impact of the investigated system, suggesting which could be the actions to reduce environmental burdens and support the municipal waste eco-balance. In this sense, renewable raw materials could be a more favorable solution to employ instead of non-renewable ones. Taking biomaterials as an example, they could be a viable option to replace conventional fossil-based materials, enabling the reduction of CO_2 emissions, because plants absorb CO_2 from the air in the photosynthesis process. The application of LCA allows for an overall evaluation of the several factors that may potentially affect the environment and are related to the municipal waste management process, in this case, organic recycling. In this regard, applying LCA to industrial composting based on the phases reported in ISO standards should define several important parameters. One of these is a functional unit (i.e., the unit of measure to which all the impact calculation shall be referred). A potential functional unit for composting can be, for example, the amount of household waste generated in a geographically defined area taking into account specific local conditions. Data used may come from direct measurement, research, experiments, and literature. For the LCI of compostable municipal waste, and thus for the assessment of its impact on the environment, the accounting of inputs and outputs of the composting process (i.e., biological treatment), must be carried out. The biological treatment of organic compounds and paper leads to biogasification, with the production of gases (mainly CO_2, CH4 and steam) and biomass (compost in an aerobic process). Biological treatment processes contribute to the stabilization of waste destined for landfill, as well as valorization in the context of biogas and compost production. The inputs may include non-segregated municipal waste, segregated bio-waste, residues mechanically separated in the fuel production process alternative, as well as energy consumption. Main outputs may include inert waste for landfill, recovered raw materials, compost, and environmental emissions. The amount of energy consumption could be assumed as 30 kWh/t of waste as input to the composting plant (50% compost production, the remaining 50% was lost to evaporation and emissions).

These data and information are an excerpt of the data needed to calculate the environmental impact of industrial composting. [31]

CONCLUSION

The results presented in this review indicate that the methodology used for testing of biodegradable packaging materials, developed in Zabrze, enables the disposal of plastic packaging wastes under industrial composting condition in a way that is friendly and safely to the natural environment and residents. However, the increasing demand for biodegradable plastics creates new opportunities, but also challenges. Thus, the European Commission introduced a proposal for a Regulation on Packaging and Packaging Waste (PPWR) which will repeal the existing Packaging and Packaging Waste Directive (PPWD) and harmonize the packaging waste regime across the EU. The Article 8 defines conditions for packaging to be considered compostable and stipulates that tea bags, filter coffee pods and pads, sticky labels attached to fruit and vegetables and very lightweight plastic carrier bags (wall thickness below 15 microns) shall be compostable by 24 months after the entry into force of the Regulation. The provision further empowers the Commission to adopt delegated acts to amend the list of packaging that need to be compostable. [32] Therefore, it is extremely important that the design of such polymers should be carried out in a responsible and sustainable manner, and the operational and design activities must be carried out taking into account aspects related to exploring the natural environment.

It may be therefore concluded, that the biodegradable packaging susceptible to organic recycling (composting under industrial conditions) seem to be a perspective panacea for decreasing of landfill waste.

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BIOBASED PLASTICS IN THE LIGHT OF DYNAMIC LEGAL CHANGES

BIOTWORZYWA W ŚWIETLE DYNAMICZNYCH ZMIAN PRAWNYCH

ABSTRACT: We live at the time of a real legislative tsunami, connected with the policy of "Green Deal" and transformation oriented to closed economy. The policy of environmental protection is found in the very heart of the EU policy. In spite of the lack of the EU legislation concerning the bioplastics at this moment, certain legal changes are related to certain aspects of their application.
The Communiqué of the EU Commission, published at the end of 2022 is one of the documents outlining the direction of the future activity connected with the biobased, biodegradable and compostable plastics.
Key words: bioplastic, compostable packaging, biodegradable packaging

STRESZCZENIE: Żyjemy w czasach istnego tsunami legislacyjnego związanego z polityką „ Zielonego Ładu" i transformacją na gospodarkę o obiegu zamkniętym. Polityka ochrony środowiska jest w samym sercu polityki UE. Mimo, że nie istnieją obecnie w UE akty prawne mające zastosowanie konkretnie do biotworzyw, to niektóre zmiany prawne dotyczą pewnych aspektów ich zastosowania.
Ogłoszony pod koniec 2022 roku Komunikat Komisji jest jednym z dokumentów wyznaczających kierunek przyszłych działań związanych z tworzywami sztucznymi pochodzenia biologicznego, biodegradowalnych i nadających się do kompostowania.
Słowa kluczowe: biotworzywa, opakowania kompostowalne, opakowania biodegradowalne

Bioplastics appear in our everyday life as an alternative to the presently dominating traditional plastics. They are employed in such applications as packaging, which constitute almost a half of demand on the discussed materials but also, in such sectors as agriculture, transport or construction industry.

In the Communiqué of the European Commission of 2021 on "Sustainable carbon cycles", the ambitious goal was set; it is expected to help in the approximation of the European economy to climate neutrality. According to the mentioned objective, at least 20% of carbon used in chemical products and that one in plastics should originate from the sustainable non-fossil resources.

The current state of the knowledge on the sustainable development of products confirms that focusing exclusively on recycling and reuse is not sufficient as to limit the green house gases (GHG) emissions and to reach the independence on fossil fuels. In order to pass really to the model of closed economy, it is necessary to replace the fossil-based fuels with the organic-origin materials, obtained by the sustainable methods.

Plastic materials of organic origin (bioplastics), biodegradable and compostable plastics are commonly perceived in Europe and at the international markets, as being more environment-friendly as compared to the traditional plastics which are based on fossil fuels and are not subjected to biodegradation. At the same time, together with the development of bioplastics, there was developed the knowledge on the conditions to be met as their production and application had a positive effect on the environment.

There is no currently EU law being specifically applying to bioplastics although certain regulations such as Directive on single-use plastic products (SUP) or Directive on packaging and

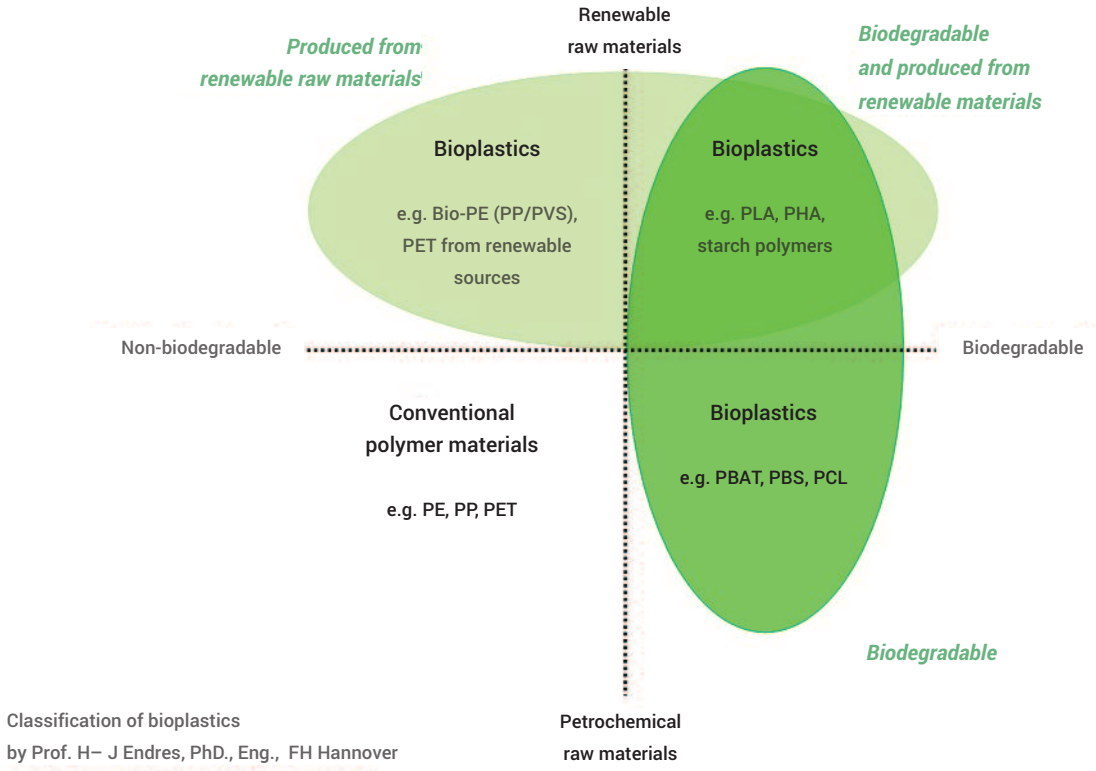

FIG. 1. CLASSIFICATION OF POLYMER MATERIALS ACC. TO THE EUROPEAN BIOPLASTIC ASSOCIATION

packaging waste together with the suggested amendments, concern certain aspects of the application of biobased, biodegradable and compostable plastic materials.

The Communiqué of the Commission, as published by the end of 2022 on the framework of the EU policy has a non-legal act character, i.e. it is not legally binding document but is reflects the opinions and intentions of the Commission concerning the mentioned materials and it will shape the EU policy such as initiatives connected with ecological statements, eco-design etc.

WHAT EXACTLY ARE BIOPLASTICS?

Bioplastics constitute a highly diversified group of materials. According to the European Bioplastic Association, the term 'bioplastics' includes the materials which are produced on the grounds of renewable sources, or are biodegradable, or combine the both mentioned features.

The materials, obtained from the renewable sources are wholly or partially made from biomass. The biomass for bioplastics may derive from such sources as e.g. maize (corn), sugarcane, or cellulose.

Biodegradability is a capacity to be subjected to chemical processes during which the microorganisms convert the polymer material into substances such as water, carbon dioxide and compost (without participation of the process-supporting aids). The process of biodegradation is dependent on the environment conditions (such as temperature, humidity, etc). To illustrate better the introduced definition, the European Bioplastic Association has developed a model, showing the particular types of polymer materials. The mentioned model is presented in Fig.1.

CLASSIFICATION OF BIOPLASTICS

Bioplastics may be classified into three groups, according to the source of origin and capability to biodegrade:

1. Plastics coming from renewable raw materials but being not subjected to biodegradation – e.g. polyamide (PA), polyethylene terephthalate (PET);
2. Plastics subjected to biodegradation (biodegradable) but not deriving from renewable raw materials – e.g. poly-buthylene adipate terephthalate (PBAT) or polycaprolactone (PCL);
3. Plastics coming from biodegradable renewable raw materials – e.g. polylactide (PLA), polyglycolide /poly (glycolic) acid (PGA) or modified starch.

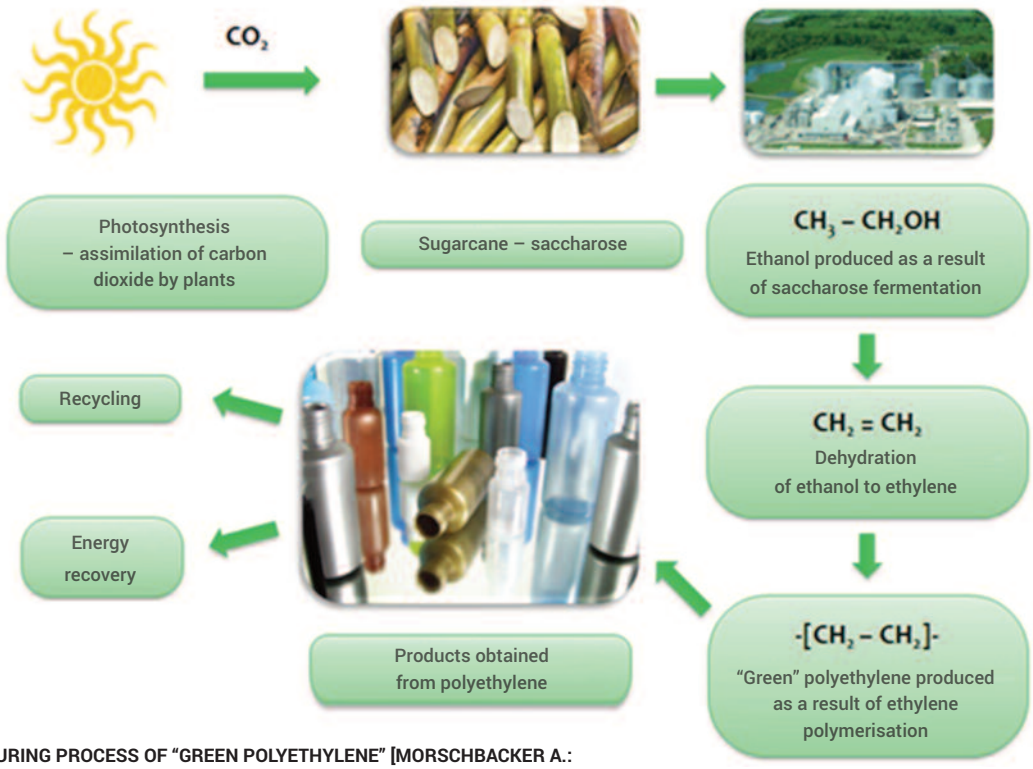

FIG. 2. MANUFACTURING PROCESS OF "GREEN POLYETHYLENE" [MORSCHBACKER A.: BIOBASED PE – A RENEWABLE PLASTIC FAMILY, BRASKEM S.A., EUROPEAN BIOPLASTICS CONFERENCE HANDBOOK, 21-22, PARIS, NOVEMBER 2007).

Non-biodegradable polymer plastics produced from renewable raw materials have the properties identical as conventional polymer plastics, obtained from the fossils. The example of such material may be the so-called "green polyethylene" which is generated as a result of polymerisation of ethylene from ethanol, obtained during the fermentation process of plant raw materials. There are few types of the "green" polyethylene, e.g. high density polyethylene (HDPE) or low density polyethylene (LDPE).

BIODEGRADABLE BIOPLASTICS

Biodegradable polymer plastics may be classified according to the origin, into polymers obtained from renewable sources and the polymers obtained from the fossils.

The difference between the mentioned two types of plastics concerns only the origin of the raw material from which they are produced. The submitted classification according to the origin is, however, only theoretical as many producers employ the mixtures of polymers, deriving from the fossils as well as from the renewable sources.

So, what is, therefore, biodegradation? Biodegradation is a complex chemical-biological process, leading to decomposition of organic matter into simpler compounds by certain microorganisms present in the environment. The biodegradation of packaging material runs gradually. At first, the process of degradation of the polymer takes place; under the favourable conditions, it is terminated by its polymerisation, i.e. decomposition into smaller fractions and generation of simple chemical compounds which constitute a nutrient for microorganisms. Fig.3 illustrates the difference between the degradation and biodegradation. If the process is ended at the stage of fragmentation, it means that the discussed above material was subjected only to degradation. The presence of the successive stage, being called mineralisation, means that the discussed material is biodegradable. The final product of degradation is biomass, water and gases: for aerobic conditions – carbon dioxide and for anaerobic conditions – methane.

The exemplified biodegradable polymers deriving from fossil sources include: synthetic aliphatic polyesters – polycaprolactone (PCL); polybuthylene succinate (PBS); synthetic aliphatic-aromatic copolymers (AAC); water-soluble polymers – polyvinyl alcohol (PVAL).

The biodegradable polymers from renewable sources are the alternative to the discussed above polymers. The mentioned plastics may replace the classical polymer materials obtained

FIG. 3. DIFFERENCE BETWEEN DEGRADATION AND BIODEGRADATION

from petrochemical sources. The materials which deserve our attention include: polylactide (PLA), polymer-starch composites, polyhydroxyalkanoates (PHA) and, also, cellulose films of new generation. The so-called "double-green" plastics are characterized by the properties similar to those of classical polymer materials and they are attractive due to their growing availability at the market.

In 2022, the European Commission adopted the framework for the policy concerning obtaining, labelling and use of bioplastics and the application of biodegradable and compostable plastics. The policy frames were published in the European Green Deal, the action plan concerning closed economy and the strategy in the field of plastics, with the aim to contribute to sustainable management of plastics. The mentioned framework explains how, under what conditions and applications, the mentioned innovative materials may bring the profits to the environment. In the cited Communiqué, there were specified the conditions which must be met by the product, determined as "biobased product" ("biological-origin product"), "biodegradable product and "compostable" product.

DEFINITION: "BIOBASED"

In the case of term "biobased" (bio-origin), the mentioned definition should be employed only when the participation of plastics in a given product is precisely and measurably specified. Besides it, the biomass must be obtained by a sustainable method, without harm to the environment. Obtaining of the discussed plastics should be consistent with the criteria of the sustainable development.

During the contacts with the consumers, the declarations concerning the biobased plastics should be referred to a real content of bio-carbon (carbon) in the product. The mentioned declarations should be performed on the grounds of calculations with the application of C-14 (radio-carbon) method in accordance with the respective standard.

Such tests are carried out and utilized by more aware producers. In Poland, the certification of packaging materials, which are produced from renewable raw materials or with the participation of renewable raw materials, belongs to the tasks of the Łódź University of Technology – Centre of Packaging COBRO.

In relation to the content of renewable raw materials, the European Plastics goes by step further and announces the thesis that the minimum level of bio-products should be promoted at the same degree as the content of materials coming from recycling in the plastic products, being specified in the proposal for a regulation of the European Parliament and of the Council on Packaging and Packaging Waste (PPWD – Directive 94/62/EC). In the opinion of the mentioned above association, organic matter as well as the content of materials, coming from recycling contribute to reduction of dependence on primary fossil sources and GHG emissions and they should be supported in equal degree.

DEFINITION: "BIODEGRADABLE"

For biodegradable products, the conditions, environment and the required time framework of biodegradation process, as expressed

FIG. 4. MARKS, GRANTED IN POLAND TO THE PACKAGING, CONTAINING RENEWABLE RAW MATERIALS

in weeks, months or years, should be determined. The indicated time frames should ensure the minimum effect on the environment. Such statements should be based on the existing standards or certification systems. The products, which as being the waste, may get to the environment, including here the products covered with the Directive on single-use plastic products, can be neither announced nor marked as biodegradable ones.

DEFINITION: "COMPOSTABLE"

To avoid misleading of the consumers, only industrially compostable certified plastics (suitable for industrial composting) should be qualified as "compostable". Besides it, they should always possess information on their destination for industrial composting. A lack of the knowledge about the correct methods of collecting the compostable packaging is the universal problem. The resulting cross-contaminations of conventional and compostable packaging waste made from plastics lower the quality of the generated recyclable raw materials. In order to direct the products of this type to the appropriate stream of waste, they should be properly marked. The Commission recommends application of readable pictograms, specifying where a given product should go after use.

The industrially compostable plastics should be employed for the specified application only when the environmental profits resulting from their use are higher than from the application of conventional plastics. Moreover, the effect of the potential consumer behaviour should be taken into consideration.

In connection with the above facts, the proposal of the Commission concerning the regulation on packaging and packaging waste requires the application of packaging made from compostable plastics in relation to the products and applications in the case of which the reduction, re-use or recycling are not possible. Moreover, the plastics of such type should not be treated as the solution of the problem of inappropriate management of waste or littering of the environment.

According to the guidelines of the Commission, bioplastics suitable for composting under industrially controlled conditions (in bio-waste processing plants) will bring the measurable profits in such applications as tea bags, filtrated coffee capsules, removed together with the used coffee products, viscous labels sticking to the fruits and vegetables and very light shopping bags.

The application of compostable plastics cannot obscure the priorities which include limitation of use of plastics and keeping all raw materials, including those of bio-origin in the life cycle as long as possible.

Summing up, the initiative of the European Commission relating to the first complex frames of the European policy in the field of bioplastics is important and necessary action – it also discovers the fact that there are still many areas, connected with the discussed materials, which divide the plastic sector and raises controversies. They include the problems connected with the assessment of the life cycle of bioplastics, utilization of land, evaluation of measurable profits for the environment, risk of cross-contamination of waste streams, and biodegradability in different environments. For the part of stakeholders, the potential of bioplastics is still promoted too carefully and the undertaken measures are still insufficient and do not reflect the main advantages of bioplastics, i.e. utilization of renewable resources for manufacture of plastic materials, and their contribution to the transformation leading towards a closed economy, being neutral in respect of carbon dioxide emission.

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ANNA NARUSZKO

INTERPACK 2023 – WELCOME HOME!

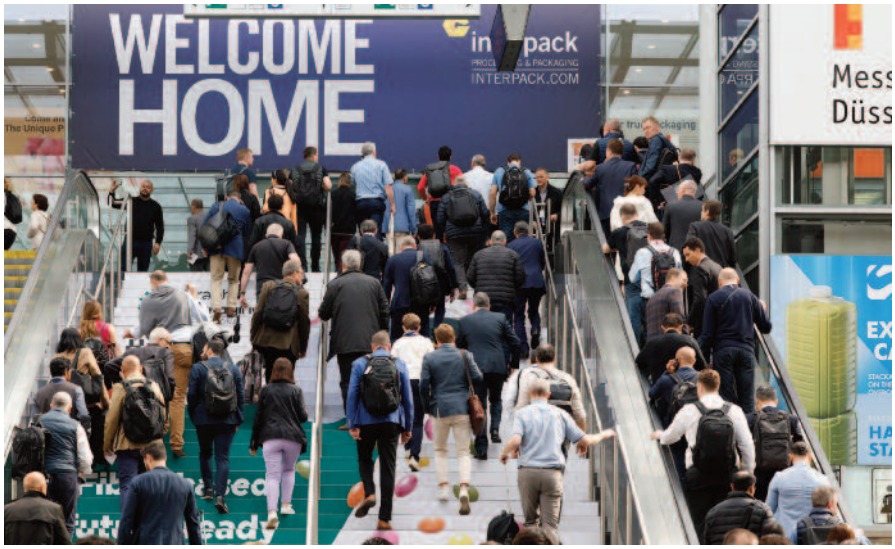
For those in the product packaging and processing business there was only one "place to be" from 4 to 10 May: interpack in Düsseldorf. Under the heading "Welcome Home" the trade fair welcomed visitors from all over the world. The joy of finally coming together as an industry was great.

It delivered what it promised and exceeded exhibitors' expectations: the world's largest and most relevant packaging trade fair set standards yet again from 4 to 10 May, connected the industry on a global level and acted as both a marketplace and content hub. Visitors from 155 countries, many with firm intentions to buy, came to interpack 2023. 2,807 exhibitors showcased the power and creativity of the packaging industry with their technologies and solutions. What was easy to see were the numerous impulses, ideas and concrete business deals which will be implemented over the coming years.

At the end of the trade fair **Bernd Jablonowski, Executive Director at Messe Düsseldorf**, says: *With interpack we were able to finally hold one of the Messe Düsseldorf's most important events again. It has reported back impressively and reinforced its position as the global platform for the exchange amongst all players in the packaging sector, related process industries and all user industries. Our targets were exceeded by far.*

Altogether approx. 143,000 visitors travelled to interpack in Düsseldorf, two thirds of them coming from abroad. Alongside many European countries, the largest visitor nations were India, Japan and the USA. Around 75% of visitors came from middle or top management.

"interpack at last!" was a phrase frequently heard in the halls – because after a six-year break the big community was finally able to meet again in person. And this was reflected in the joy on people's faces. *interpack 2023 will reverberate with us for a long time – both in business and personal terms*, says **Director**



UNDER THE HEADING "WELCOME HOME" THE TRADE FAIR WELCOMED VISITORS FROM ALL OVER THE WORLD

Thomas Dohse after seven trade fair days adding: *The mood in the halls was great and the inter-cultural exchange enriching for all sides. It was 'simply unique' again.*

This was underscored by the positive feedback from visitors, 96% of whom stated they had achieved their trade fair objectives. Just as satisfied were the exhibitors whose expectations had been exceeded many times over. *We thank Messe Düsseldorf for the outstanding organisation. I'm confident that I'm speaking on behalf of all companies here. interpack 2023 is simply a must for suppliers and users from all over the world to exchange experiences and do business*, says Markus Rustler, President of interpack 2023 at the conclusion of the event.

TRANSFORMATION AS AN OPPORTUNITY

Considering current market developments, the enormous challenges but also the even bigger opportunities, this interpack definitely proved one of the most important ones in its history. The need to automate, the will to act sustainably and changed consumption habits are all expressions of transformation.

THE NEED TO AUTOMATE, THE WILL TO ACT SUSTAINABLY AND CHANGED CONSUMPTION HABITS ARE ALL EXPRESSIONS OF TRANSFORMATION IN THE PACKAGING INDUSTRY

ALL FACETS OF SUSTAINABILITY WERE TOP THEMES AT INTERPACK. EXHIBITORS PRESENTED HIGH-END TECHNOLOGIES AND HOLISTIC CONCEPTS THAT CONSIDER EFFICIENCY AND SUSTAINABILITY ALONG THEIR ENTIRE PRODUCTION LINE

interpack's strategic orientation towards the four Hot Topics: Circular Economy, Resource Management, Digital Technologies and Product Safety found concrete expression in numerous innovations. The trade fair, which has traditionally been a key cornerstone in the innovation cycle of the packaging industry and related process industries, also more than lived up to this claim this year.

SUSTAINABLE PACKAGING TECHNOLOGIES

All facets of sustainability were top themes at interpack. Exhibitors presented high-end technologies and holistic concepts that consider efficiency and sustainability along their entire production line. *Many companies in the consumer goods industry have set their own sustainability targets*, says **Richard Clemens, Managing Director of the Food Processing and Packaging Machinery Association within VDMA at interpack**. *Over the past few years, packaging machinery manufacturers have succeeded in implementing sustainable packaging concepts by means of corresponding technical adaptations and newly developed machinery solutions. interpack is the showcase for innovations and, at the same time, the point of departure for developing further towards a sustainable circular economy*, says Clemens summing up.

The many solutions celebrating a world premiere at interpack also included a host of packaging materials and supplies in all their diversity. In excess of 1,000 exhibitors were showcased in this segment alone, making for a new record.

FORWARD-LOOKING CONTENT

interpack is not only a business but also a content platform for the sector, both live and digitally. A total of 50 talks were hosted at the Tightly Packed TV studio care of interpack and 'packaging journal', thereby generating additional visibility and reach of the top themes and trends through live streams. Some 200,000 viewers dialled in during the run-time of the trade fair alone.

The Spotlight Talks & Trends Forum proved a visitor magnet and focused on seven themes on seven days including amongst others, logistics, circular economy and e-Commerce. The programme was presented jointly by interpack, the dfv Conference Group and PackReport.

NEW AND FRESH IMPULSES

Also attracting plenty of attention were the other Specials such as the interpack Start-up Zone, the joint stand Co-Packing, several award ceremonies spotlighting exciting packaging innovations, the 'SAVE FOOD Highlight-Route' with new approaches to fighting global food loss and waste and the promotion of women at 'Women in Packaging'. The special buzz at this premiere came by way of the approximately 200 women from the international sector, who exchanged and established new networks during interpack.

components – which was held as a concurrent event with 80 exhibitors in a separate hall – also went down well with visitors. The upstream industries supplying components and software to packaging technology and process engineering play a prominent role in the digitalisation of manufacturing processes.

The next interpack will be held in Düsseldorf from 7 to 13 May 2026.

HIGHLY VALUABLE CONTRACTS AND WONDERFUL ATMOSPHERE AT PLASTPOL 2023

More than 600 companies from the entire world and all 7 exhibitions halls occupied - it is a result of this year's edition of the Fair of Plastic and Rubber Processing, Plastpol. The mentioned event, organized in the seat of the company Targi Kielce for 27 years, has come back after the pre-pandemic form, maintaining its international prestige.

For the processing sector, few days spent within the halls of Targi Kielce during the mentioned Plastpol were almost treated as a holiday. The best evidence of it includes the unique atmosphere of mobilization to acting, meeting and making contacts.

During this year's Plastpol we had the occasion, which is rather a rare fact at the present time, to drink a congratulation glass of champagne due to the fact that we were able to sell some machines and make some customers interested in our offer – Konrad Szymczak from Arburg Polska says.

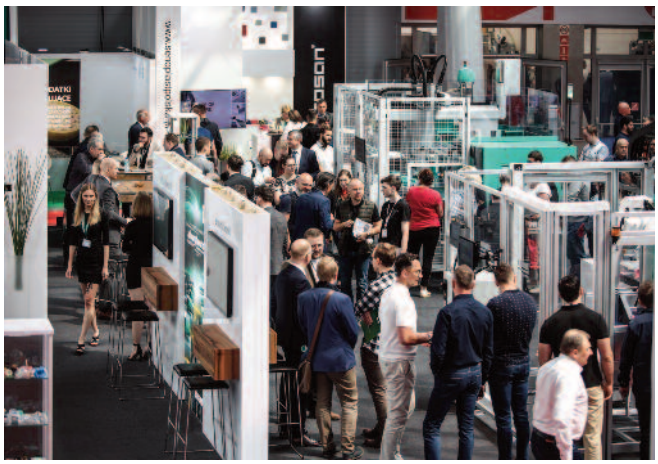
Our stand was full of clients and, also, of the persons who wanted to get familiarized with our newest technologies, for example in the range of Industry 4.0. As far as the Fair itself is concerned, the whole organization and infrastructure, from auxiliary service commencing to marketing and PR, everything was very good. We are present here every year and we will come also the next year – Adam Marciniak from Engel Polska assures.

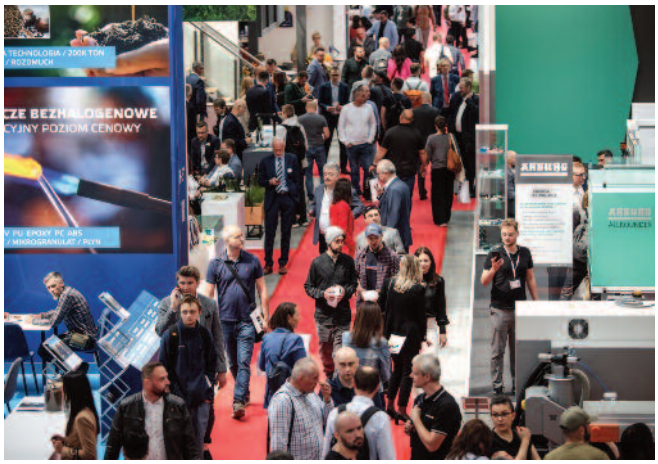
CONTRACTS WORTH MILLIONS

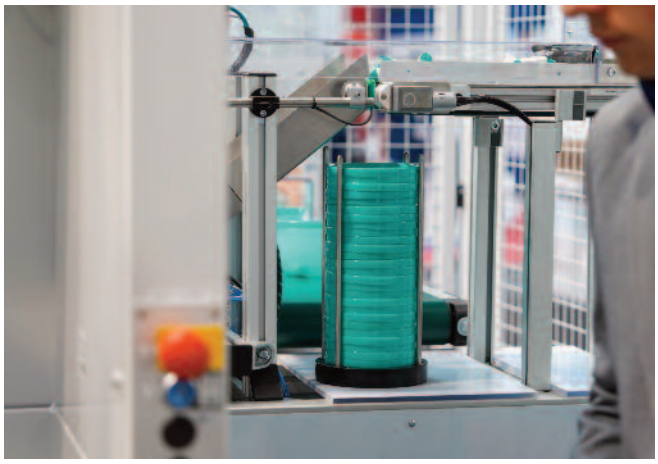
Apart from meetings and contacts, The Fair events are also a good occasion for industrial "boasting". Therefore, many companies decide on signing the important contracts just during the Fairs. The same situation has place this time.

Polish producer Bogucki Foils signed the contract worth 7 million EURO with the German company Reifenhäuser for the purchase of manufacturing line. The negotiations had lasted for few years and the mentioned investment is expected to

THE EXHIBITORS FROM 29 COUNTRIES PARTICIPATED IN PLASTPOL'23. IN THE EXHIBITION HALLS OF TARGI KIELCE WE COULD MEET THE REPRESENTATIVES OF THE COMPANIES FROM SUCH COUNTRIES AS INDIA, TÜRKIYE, ITALY, GERMANY, PORTUGAL AND, ALSO, JAPAN, THE SOUTH KOREA, TAIWAN AND CHINA







FOR THE PROCESSING SECTOR, FEW DAYS SPENT WITHIN THE HALLS OF TARGI KIELCE DURING THE MENTIONED PLASTPOL WERE ALMOST TREATED AS A HOLIDAY. THE BEST EVIDENCE OF IT INCLUDES THE UNIQUE ATMOSPHERE OF MOBILIZATION TO ACTING, MEETING AND MAKING CONTACTS

raise the Bogucki company to the new level. *The mentioned purchase will allow doubling our production. It is important to ensure the chain of supplies. Carrying out the total production in one line is little dangerous. We must possess a separate line being fully capable of taking over the load of production. Such measure will enable becoming a leader of barrier foils in Poland and in this part of Europe* – Andrzej Bogucki, the President of the Bogucki Folie company says. – *In the future, we will think about such outlet markets as Lithuania, Ukraine, Latvia, Estonia or even Belorussia. The "south" market i.e. Rumania, Bulgaria or Croatia, is also found in our reach.*

On the occasion of signing the agreement, Ulrich Reifenhäuser from CSO Reifenhäuser Group presented his opinion on the Polish – German trade relations. *I think that Polish market is significant. We may observe how quickly it is developing; it may be mainly reflected by the number of the recent Polish investments. It anticipated that Poland will become soon the important country for German processing industry. Due to the differences in the costs of energy consumption and of logistics, plastic products from Poland have a chance to conquer the German market* – he stated.

During Plastpol 2023, there was also signed the first distribution agreement between Polish plastics-recycling company ML Polyolefins and distributor from the Western Europe, Brenntag company. Owing to the mentioned contract, ML Polyolefins will export the products to sic countries: Denmark, Sweden, Finland, Norway, the Czech Republic and Slovakia.

The task of Brenntag company is to reach the customers who will utilize the mentioned products. It is important that the product meets the requirements of the clients though recycling and manufacture of a recycled product (recyclate) being equal to original product in respect of quality, is not easy. The standardization of the products coming from recycled materials seems, therefore, the necessity if we want to introduce them into market with success – Tomasz Mikulski, the President of the Board of ML Polyolefins said during the press conference.

Sara Ghione, Director at Brenntag Polymers EMEA mentioned that her company decided to cooperate with ML Polyolefins because the discussed company is known from the excellent functioning in recycling sector. *It ensures high quality product which will find the customers* – she said.

The sector has not said the last word. Traditionally, at the beginning of this year's edition of Plastpol Fair, Foundation Plastics Europe submitted its own annual report on processing industry sector. Although foreign trade balance of plastics industry in 2002 in Poland was negative (1 million 879 thousand tonnes), it is, however, better result than that one of 2021; it was caused owing to lower (by ca. 0.5 million tons) import of polymers and systematically increasing export of plastic products. Moreover, the employment in the discussed branch of economy has been increased.

This year's Plastpol was especially important in the light of geopolitical changes in Europe which have the effect on supply chains and outlet markets.

Poland has a chance to occupy the place of Russia and Byelorussia as a significant country in trade of plastics and rubber. Therefore, the exhibitors from 29 countries participated in Plastpol'23. In the exhibition halls of Targi Kielce we could meet the representatives of the companies from such countries as India, Türkiye, Italy, Germany, Portugal and, also, Japan, the South Korea, Taiwan and China.

The successive edition of Plastics and Rubber Processing Fair Plastpol is planned on 21-24 May, 2024.

DEVELOPED ON THE GROUNDS OF MATERIALS OF TARGI KIELCE

Packaging Review

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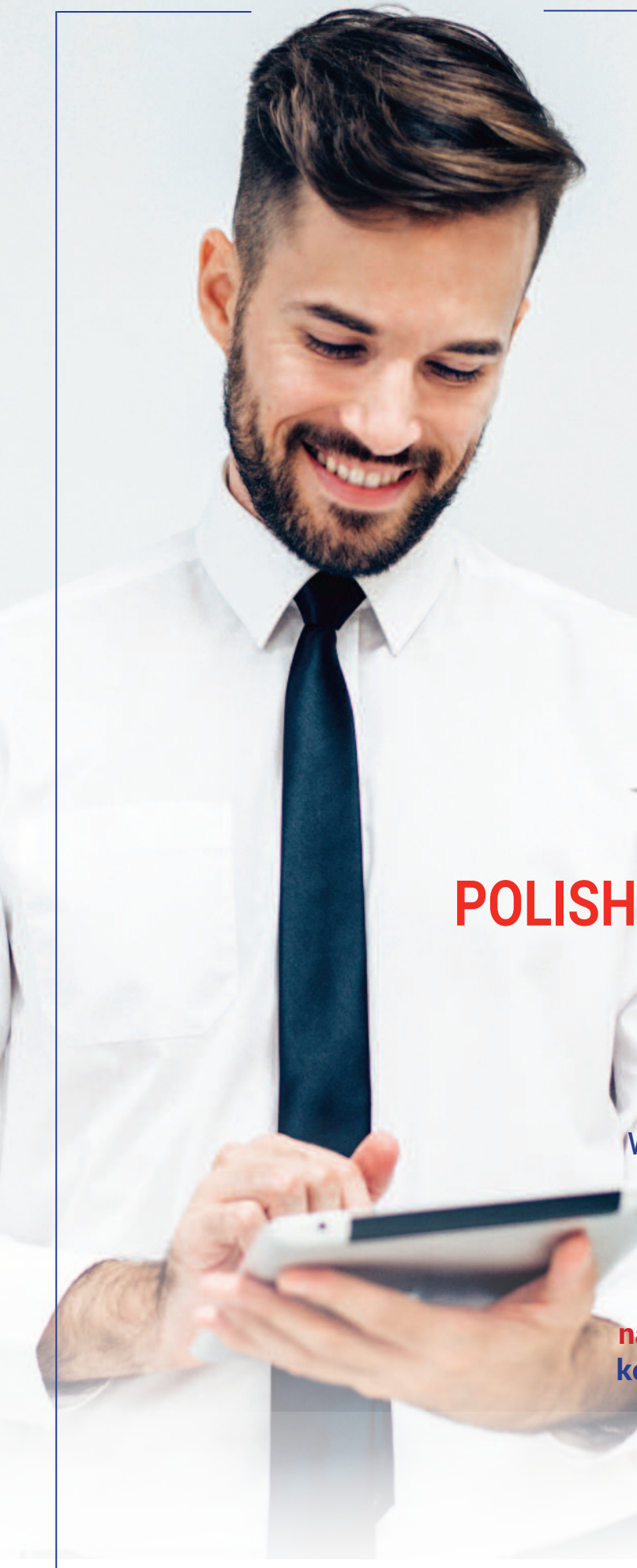

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