General issues and the recommended standards for corrugated board and corrugated board packaging

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information paper

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The Association of Polish Papermakers

The Association of Polish Papermakers (SPP) is a research, engineering and management organisation, associating individuals and corporate members active in the paper-making and paper-converting industry and its business and scientific environment. Our mission is to support the development of the papermaking and paper converting industry in Poland as well as to integrate the community of papermakers.

The Association has four Sections:

- Technical Section,
- Paper Section,
- Corrugated Board Section
- Infrastructure Section.

Activities include:

- representing SPP vies-a-vis national and local authorities, commercial chambers, business organisations and others;
- monitoring changes in the legal system and reviewing documents drafted by governmental agencies and related to the papermaking industry and its environment;
- analysing the level of supplies of raw materials and components to papermaking industry;
- supporting the recycling of paper, board and paper waste;
- keeping track of the Best Available Techniques (BAT) in the paper making and paper converting industry;
- monitoring energy market, including renewable energy;
- reviewing amendments to fiscal regulations and developments in environmental protection education.

SPP also has its international operations:

- membership in international organisations - CEPI (Confederation of European Paper Industries) and FEFCO (European Federation of Corrugated Board Manufacturers),
- well-established relations with research and technical papermaking organisations in the world, such as TAPPI (USA), PPTAC (Canada), PITA (United Kingdom), FPEA (Finland), SPCI (Sweden), ZELLCHEMING (Germany), ATIP (France) and IPH (Brussels).

Our Technical Section is composed of individuals and the supporting members. Its activities include: organisation of conferences, symposia and trainings; publishing; collecting and publishing historical records, Expert Group.

The SPP Paper Section associates corporations (SPP Supporting Members) – producers of pulp, paper and board. Among our members there are 13 companies which together manufacture 80% of the Polish paper and board production. The Paper Section - assisted by a consulting firm – monitors the legislative process in the field of environmental protection and provides consultancy services on changes of legal regulations applicable to the paper industry.

The Corrugated Board Section of SPP associates corporations (the Supporting Members of SPP) – producing or converting the corrugated board. Currently there are 16 companies in the Section, which in total produce ca. 82% of the national production of corrugated board and packagings thereof. The Section is active in the area of common interest of its Members, including: promotion of the corrugated board containers and a product which is fully recoverable and environmentally friendly. Within a promotional campaign of packagings made of the corrugated board a special logo has been designed “Paper packaging offers nature friendly quality”. The logo in various colours is protected and used by the Section Members in their promotional campaigns. The Section also organises trainings for its Members.

The SPP Infrastructure Section groups the following SPP Supporting Members: academic, training and R&D centres, designing & engineering agencies, commercial companies, producers of machines and equipment, providers of services for the papermaking and paper-converting industry. The Section supports the Technical Working Group for Pulp & Paper Production. The Group is working in the amendment of the reference document concerning the best available techniques in the pulp and paper industry (BREF). The Group is chaired by one of the SPP experts.

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Lodz. 28th June 2011

O P I N I O N

on a paper entitled: "The general issues and the recommended standards for corrugated board and corrugated board packaging" written by Marek Bielecki, Anna Chmielewska-Wurch, Tomasz Damięcki, Beata Patalan, Maciej Słoma and Sławomir Ździebło.

The corrugated board is the globally most frequently used packaging material used for the production of both primary and secondary packagings. In volume terms, this is the largest group of paper products manufactured in Poland. Due to such features as strength to weight ratio, suitability for marketing purposes, low transport and storage costs as well as its easy utilisation and/or recycling capacities, production of corrugated board has promising growth prospects. The growing interest in this packaging medium results in the increasing demand for information on its manufacturing and converting. The rapid technological progress of the recent decade has been visible both in the manufacturing technology of the corrugated board and packagings, and in the construction of machines for their production. The increasing range of corrugated products as well as the technical progress lay down demanding requirements for a continuous refreshment of knowledge in various technical fields, a know-how which is not commonly available.

The paper entitled "The general issues and the recommended standards for corrugated board and corrugated board packaging", is a valuable supplement to the Polish literature of the subject. The Authors – in order to meet the expectations of the producers and users of the corrugated board – have presented in a straightforward manner the educational material, containing elementary information for the sector of corrugated board packagings. The publication includes a wide variety of topics, covering the production cycle of packagings, starting with the materi-

als, machines and technologies used for the production of the corrugated board, through the machines and technologies for manufacturing and printing of blanks, and ending with folding and gluing the packagings.

The paper presents basic parameters of corrugated boards and packagings thereof, as well as their testing methodology. Moreover the publication contains packaging classification, their application principles and criteria for packagings having contact with food.

Due to the fact that the Authors represent different professional specialties, at the same time being a team of experienced and highly valued experts, the paper contains useful practical information, which may be used for training of new staff, both by packaging producers and by their contractors.

The publication is written in the plain Polish language, however frequently we can find industry jargon, which is not compatible with the proper Polish nomenclature. When presenting the educational content, special attention should be out to the vocabulary, in order to avoid bad linguistic habits.

Taking into consideration the content of the publication, I can definitely acknowledge that the Authors have achieved their goal, and their work will popularise the know-how in the area of manufacturing packagings of the corrugated board, both among the producers and in their business environment.

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Warsaw, 28th June 2011.

O P I N I O N

on the publication entitled : "The general issues and the recommended standards for corrugated board and corrugated board packaging", by Marek Bielecki, Anna Chmielewska-Wurch, Tomasz Damięcki, Beata Patalan, Maciej Słoma and Sławomir Zdziebło.

Packaging materials made of paper and board, including the corrugated board – are among the most frequently used media for collective and unit packagings, also used for foodstuffs. Thus the users should have knowledge concerning the medium properties, and consequently its adequate application. Therefore it is necessary to understand the requirements of the production process – starting with the raw materials, through the paper and board forming technology, various types of packagings and finally the logistics of the filled containers.

The authors – from the Association of Polish Papermakers – have responded to the industry need and presented an interesting information material in the area in question.

The paper in details presents the process of the corrugated board production, including among others the diagrams of the most frequently used gluers and corrugators.

Then there is a description of types of packagings made of the corrugated board, i.e. rolls (reels), different types of boxes (including SRP, FEFCO classification catalogue) as well as the modern methods of imprints application (markings, product and marketing information).

A very good idea was to give a clear presentation of the main features and parameters of the corrugated board and packagings thereof, together with the testing methods.

It should also be stressed that special attention has been paid to the packaging process, adequate stacking on the pallet, storage and relocation by various means of transportation.

An important element of the reviewed publication is the thorough description of the standard requirements for the corrugated board packagings, used in the circulation and production of food – which is particularly important (e.g. recent problems with export of food to the Russian market).

My opinion of the reviewed paper is high. It gives a general overview of the corrugated board production, packagings and their characteristics, and the in-depth analysis of application opportunities. In the subsequent editions of the publication I would suggest adding a section on the recycling of the used packagings.

Concluding – I recommend as quick as possible publication of the reviewed paper on a popular packaging material i.e. the corrugated board and various products made of that medium.

I would like to congratulate the Authors on their interesting presentation of the analysed area, and I encourage everyone to read the publication.

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1. Introduction

The dynamically developing market trends in the broadly understood packaging sector, new arising customer needs, demand for flexible and non-standard actions, as well as the variety of challenges faced by the corrugated board producers, necessitated the publication – under the auspices of the Polish Association of Polish Papermakers – of an info on standards applied in the sector of the corrugated board and packaging made of corrugated board. This task has been assigned to a team of experts and producers of corrugated board packagings. Using their know-how and experience as well as the best coopetition practice, the team has presented the essential issues of manufacturing and processing of the corrugated board: manufacturing, technology, logistics and legal requirements applicable to the corrugated board producers.

This paper contains all basic information concerning the raw materials used for the production of corrugated board, types of produced corrugated boards and packagings, the process of manufacturing corrugated board and its processing into packagings, essential parameters of corrugated boards and parameters of packagings made of corrugated board, and finally the information on requirements for packaging that come into contact with foods.

This paper is directed both to persons from the corrugated board sector and to their customers. It may be used as an excellent guide, but also as a basic manual – the ABC for the packaging sector. It should certainly facilitate communication between the two interested parties – packaging producers and their clients.

We are deeply convinced that this paper will not only provide you with the information on the recommended standards, but will also add to the technical and technological knowledge on the application of the corrugated board and packagings produced thereof.

We hope you enjoy the text.

2. Components used in the manufacturing of corrugated board and packagings

a. Papers

The major component for the production of corrugated board is paper. According to the type of application and their properties, papers used for corrugated board production may be divided into two groups:

- Papers for flat layers – liners,
- Papers for corrugated layers – flutings.

Liners – depending on their manufacturing process and the component composition – belong to one of the two main groups:

- kraftliners,
- testliners.

Kraftliners – have the best strength parameters among all the liners. They are composed of the cellulose pulp with a slight addition of the recycled fibre. Usually the overcoat is better glued and has a higher smoothness.

Topliner (white kraftliner) is a grade of kraftliner. Its overcoat in most cases is made of bleached kraft pulp, while the bottom layer – of the non-bleached stock. For the more advanced imprints white coated kraftliners are used – the overcoat is mostly coated with a pigment coating colour.

Testliners – are the two-layer papers, most frequently made of 100% recovered paper. A testliner is a combination of two layers. Such construction enables the use of kraft pulp for the overcoat, and the recycled fibre for the bottom layer. Due to the price relation between the expensive cellulose mass and the cheaper paper stock, we observe the contiguous growth of the latter in the testliner recipes. More and more they are entirely made of the recycled fibre. In such cases the overcoat (top layer) is dyed in order to imitate the colour of the kraft pulp. Similarly to kraftliners, testliners are manufactured with the white overcoat of similar whiteness. For the more advanced imprints the coated testliners are produced, where the overcoat is most frequently coated with the pigment coating colour.

In addition to the above described regular papers special papers with specific properties are also applied. These include among others:

- wet-strength papers – converted to ensure maintaining strength properties after wetting (PN-P-50000:1992),
- fat-tight papers – high resistance to fat and grease penetration. Some of these papers are particularly resistant to the penetration of the above mentioned substances (PN-P-50000:1992),

- barrier coated papers – with a protective layer, e.g. of polyethylene (PE), covering one or both paper sides (PN-EN 26590-1:1993),
- fireproof papers – flame and/or ignition resistant (PN-P-50000:1992).

Paper for flutings are divided into two groups:

- waste based fluting (WBF),
- semi chemical flutings (SC).

WBF – is manufactured exclusively of the recycled fibre.

In order to improve its mechanical properties of such fluting, starch is added to its structure. This process is popularly described as bonding. It may be carried out „in the stock" (i.e. sizing - starch is introduced into the waste paper pulp) or starch may be additionally applied on the paper surface (surface sizing).

The semi-chemical fluting contains ca. 70% of the semi-chemical pulp, manufactured from hardwood (mostly birch) in the pulping process. The remaining part of this pulp consists mostly of the recovered paper.

b. Corrugating glues

The most popular glues for bonding the layers of the corrugated board are starch glues. Their strengths include biodegradation and renewable source of origin.

Major components of the starch glue:

- converted or native starch – mostly maize or wheat,
- caustic soda,
- borax,
- water.

Starch – polysaccharide appearing in a granular form in the tissues of certain plants and composed almost exclusively of alpha-d-glucose radicals (PN-A-74820:1987). In Europe it is industrially produced mostly of maize and wheat, less frequently of potatoes.

Sodium hydroxide (caustic soda) is used to decrease the glue gel point. Crude starch has a gel point at 75-80^{o}C. Such joint temperature is difficult to obtain in corrugation process on the corrugator, also being disadvantageous for the technology, as it may cause overheating of the recto. Therefore the gel point is decreased to ca. 55ºC. Moreover, sodium hydroxide facilitates the penetration of the glue into the paper.

Borax (hydrated sodium tetra borate $Na_2B_4O_7x10H_2O$) stabilizes the glue, reacting with the cooked starch, improves glue adherence and its penetration into the paper.

Water is a carrier and facilitates the swelling of starch granules.

c. Inks

Various printing techniques are applied (screen print, offset) in the process of packaging production, however the most popular method is flexo printing – using flexographic printing inks.

Flexographic printing inks

Typical flexographic inks include:

- pigments,
- binders,
- emulsion resins,
- dispersion resins,
- additives,
- water – as a solvent.

Pigments form ca. 10% of the ink mass. They provide colour to the printing inks. Mostly organic pigments are used for the production of the flexographic inks. Titanium dioxide is the most frequently used white pigment.

Binders constitute about 20% of the ink mass. Acrylic resins (derivatives of acrylic acid) are used as bonding agents in water-based inks. Ink binder is responsible for the ink utility as well as the scope of application. Compositions of two types of acrylates are used – emulsions and dispersions.

Emulsion resins are soft, flexible, have no gloss and are used in inks for the uncoated papers.

Dispersion resins are hard, fragile, glossy and quick-drying and thus they are used in inks for coated papers.

Additives form ca. 5% of the ink mass. Depending on the purpose of application there are:

- waxes,
- surface-active agents,
- antifoam agents
- drying retardants or accelerators.

Waxes are used in order to improve ink rub resistance by reducing contact area and improving slippage. In the flexographic inks synthetic waxes (polyethylene) are used.

Surfactants are wetting agents, introduced into the inks in order to reduce the surface tension. This prevents problems with wetting during pigment distribution and printing.

Antifoam agents in their majority are silicone and fatty acid defoamers.

Drying retardants or accelerators are glycols or higher alcohols delaying ink drying and improving the bond of polymer particles.

Offset inks

Offset inks due to the printing technology may be divided into the following three main groups:

- inks for sheet printing,
- inks for web printing, fixation by absorption (cold-set type),
- inks for web printing, fixation by evaporation of the high-boiling solvent heated with hot air or flame (heat-set type).

Table 1 shows average compositions (in %) of the above mentioned offset inks.

Ink components	Sheet inks	Cold-set inks	Heat-set inks
Pigments	15-25	20-25	15-25
Resins	25-20	8-12	25-35
Alkyd resins/ drying oils	20-30	0-12	5-15
Mineral oil	20-25	60	25-40
Additives	5-10	1-5	5-10

Table 1. Composition of offset inks (%)

Offset inks, due to the specific printing technology (ink transfer via an intermediate cylinder – offset cylinder) and low ink thickness on a printout (1-2 μm), must have high colour strength and significant light fastness.

These inks must also have certain hydrophobic properties – printing and non-printing elements of the offset plates are placed in the same plane. Printing elements have hydrophobic properties, non-printing are hydrophilic. Thus in order to enable the printing process, ink must not wet the non-printing elements of the form, and it should only be taken over by the printing elements.

3. Corrugated board

a. Types of corrugated boards

Corrugated board – board made of one or more layers of fluted paper, alternatingly sized with one or more layers of paper – facings.

Depending on the number of layers in the corrugated board there are:

- Single-faced corrugated boards – boards composed of one ply of fluted paper sized to one layer of facing (PN-P-50000:1992) (Fig. 1);

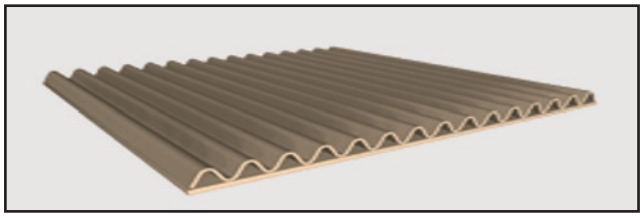


Fig. 1. Single-faced corrugated board

- Double-faced corrugated boards – boards made of three layers. One ply of fluted paper sized between two layers of facing (PN-P-50000:1992) (Fig. 2);

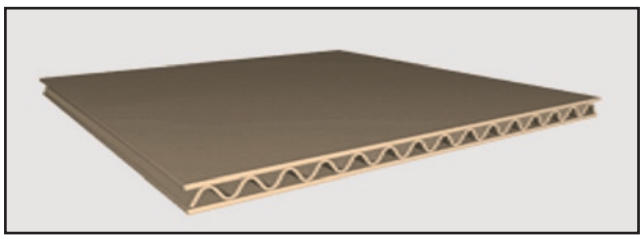


Fig. 2. Double-faced corrugated board

- Double-double corrugated boards – boards composed of five plies. Two fluted layers sized alternatingly between three facings (PN-P-50000:1992) (Fig. 3);

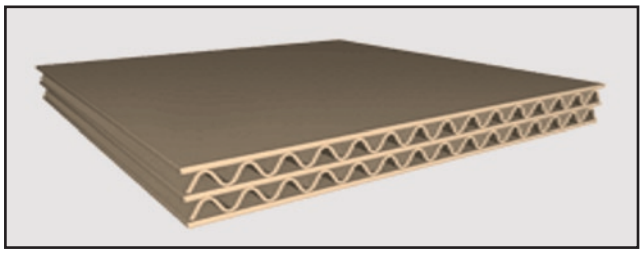


Fig. 3. Double-double corrugated board

- Tree-wall corrugated boards – boards composed of seven plies. Three fluted layers sized alternately between four plies of facing (PN-P-50000:1992) (Fig. 4).

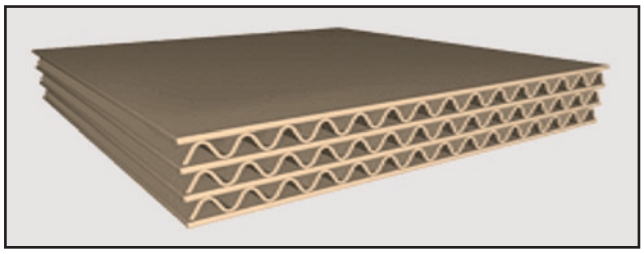


Fig. 4. Tree-wall corrugated board

Not as frequent as the above mentioned types but still available are also four and nine-ply boards.

Moreover, there are the following special purpose boards:

- hydrophobic boards (moisture proof, with waterproof adhesive),
- boards with tape (tear-off or reinforcing tapes),
- barrier boards – waterproof, greaseproof boards (PN-P-50000:1992) and others,
- preprint boards,
- fireproof boards (PN-P-50000:1992).

b. Flute profiles

Flute profile depends on the type of fluters used for the production and it is a characteristic indicator of the corrugated board. The most frequently used profiles include flutes: B, C and E. Moreover, there are corrugated boards with flutes: D, K, A, F, G, N, O. The most important characteristics of the above mentioned profiles include:

- flute height,
- flute pitch,
- take-up ratio

Flute height (B) is the vertical base to peak distance of a flute, while the flute pitch (A) is the horizontal distance between adjacent flute peaks adherent to the same ply. (Fig. 5).

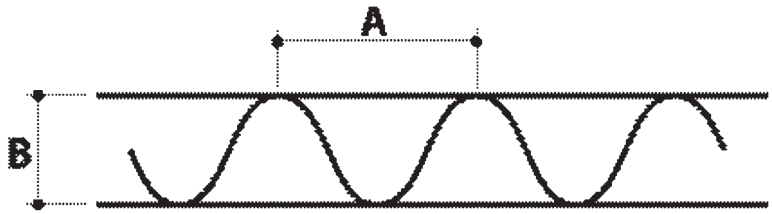


Fig. 5. Flute profile

The take-up ratio is defined as the ratio of the length of the non-fluted corrugated medium to the length of the fluted web.

These parameters are characteristic for particular types of fluters and may differ between various manufacturers. In most cases parameters are within the ranges presented in the Table 2 below.

Profile	Take-up ratio	Height [mm]	Pitch [mm]
O	1.14	0.3	1.2
N	1.11 – 1.8	0.4 – 0.5	1.8
G	1.17	0.5	1.8
F	1.19 – 1.28	0.7 – 0.8	2.4 – 2.5
E	1.20 – 1.35	1.1 – 1.4	3.2 – 3.7
B	1.26 – 1.48	2.3 – 2.8	6.1 – 6.6
C	1.36 – 1.56	3.4 – 4.0	7.4 – 8.3
A	1.37 – 1.53	4.1 – 4.7	8.7 – 9.5
K	1.50	5.94	11.7
D	1.48	7.38	15.0

Table 2. Flute profile parameters

4. Technological process of corrugated board production

Corrugated board is produced on the machine colloquially called a corrugator, which is a sophisticated production line of 100-140 m, composed of a number of mated sub-assemblies and installations.

A corrugator has the following main subassemblies:

- single facer,
- double backer,
- heating and drying section,
- longitudinal cutter,
- cross cutter,
- piler.

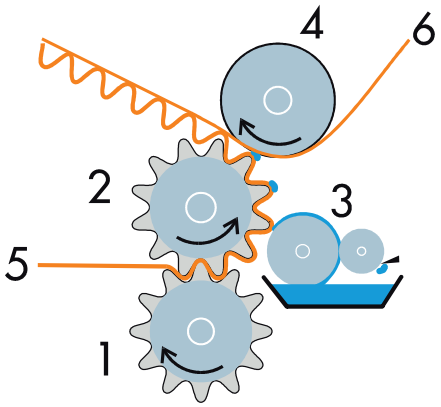
In order to start the production of corrugated board, it is necessary – in addition to standard media, such as electricity, water, compressed air – to supply heat required for the sizing process. Generally boilers (gas or oil-fired steam generators) are used, which can generate steam at pressures of up to about 18 bar. Such steam enables the adjustment and control of heating of many elements of the corrugator in the range of temperatures reaching even 200°C.

Another component - essential for bonding of paper plies - is a starch glue, which is usually prepared in the glue preparation plant.

The process of board production starts on the single facer, which belongs to the wet end of the corrugator (Fig. 9). The earlier prepared adequate paper rolls – fluting and liner – are fed into the single facer, where the first two board layers are sized.

Fluting, after being heated and passed under pressure between the fluters, receives the characteristic flute. The type of fluters, i.e. the shape of flutes thereon (of particular parameters such as flute pitch and height) is decisive for the type of the produced corrugated board and its utility. Then, the peaks are thoroughly covered with a small amount of the starch adhesive. In the next step the heated liner is sized with the fluting. Due to the pressure applied on papers while transferred between the pressure roller and the fluter, and in result of the temperature, generated by the rollers heated with steam, adhesive joint binds the two papers. The single-faced corrugated board is the product of this process. It is then used as a component for further processing or a final product. A single-faced corrugated board is a flexible material which can be reeled, and is the simplest product used for example as a protective wrapping or lining for various surfaces and goods. Another important field of application is the laminating process.

A diagram of the single facer is presented in Fig. 6, while Figures 7 and 8 present respectively: a single facer with a pressure belt and with a pressure roll.



1 – Bottom fluter
2 – Top fluter
3 – Corrugated board sizing machine
4 – Pressure roll or belt
5 – Fluting
6 – Liner

Fig. 6. Single facer diagram

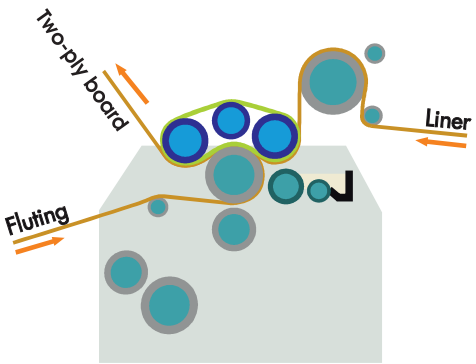


Fig. 7. Single facer with a pressure belt

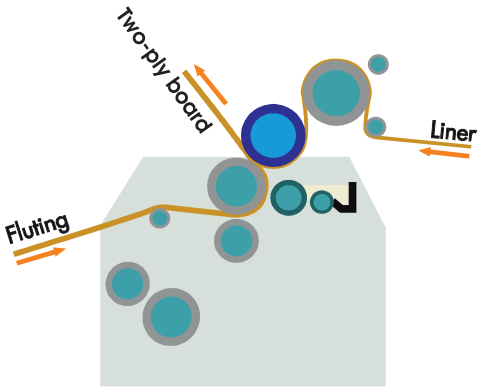


Fig. 8.Single facer with a pressure roll

The next stage in the production of the corrugated board is sizing the second liner. Single-faced corrugated board produced on a single facer travels along the special bridge to the double facer. In this part of the corrugator glue is applied on the corrugated medium, and then the such prepared web of the single-faced corrugated board leaves the “wet end” of the corrugator and is fed to the double facer, which belongs to the “dry end” (Fig.10). At the same time the facing is fed under the corrugated board

web. The process of final bonding is carried out on the double facer. The corrugated board web runs between the surface of the heated table and a movable pressure belt, usually called a “drying belt”, where excessive moisture is evaporation (steam). Running through the double facer ensures also adequate setting if the adhesive joints.

In order to produce a multi-faced corrugated board, the corrugator must be equipped with several single facers – two for the five-ply board and three for the seven-layer board.

Then the corrugated board goes to the cutter section. The first stage is web longitudinal cutting. This is done on slitter scorer. The board web is cut perpendicularly to the flute orientation into the required widths (sizes). Simultaneously the side edge is trimmed in order to provide straight edges of the outer sheets (a trim is produced). Creasing is also possible while longitudinal cutting (for future folds) of the board sheet. The creased sheet is a component for the production of flap boxes. The next step is the cross-cutting of the web, i.e. parallel to the flute orientation.

The section where this is done is called a sheeter. In most cases it contains two (sometimes three) independent sets of rolls with cutting knives. This enables a simultaneous production of one, two or even three sizes of sheet from the same type of corrugated board.

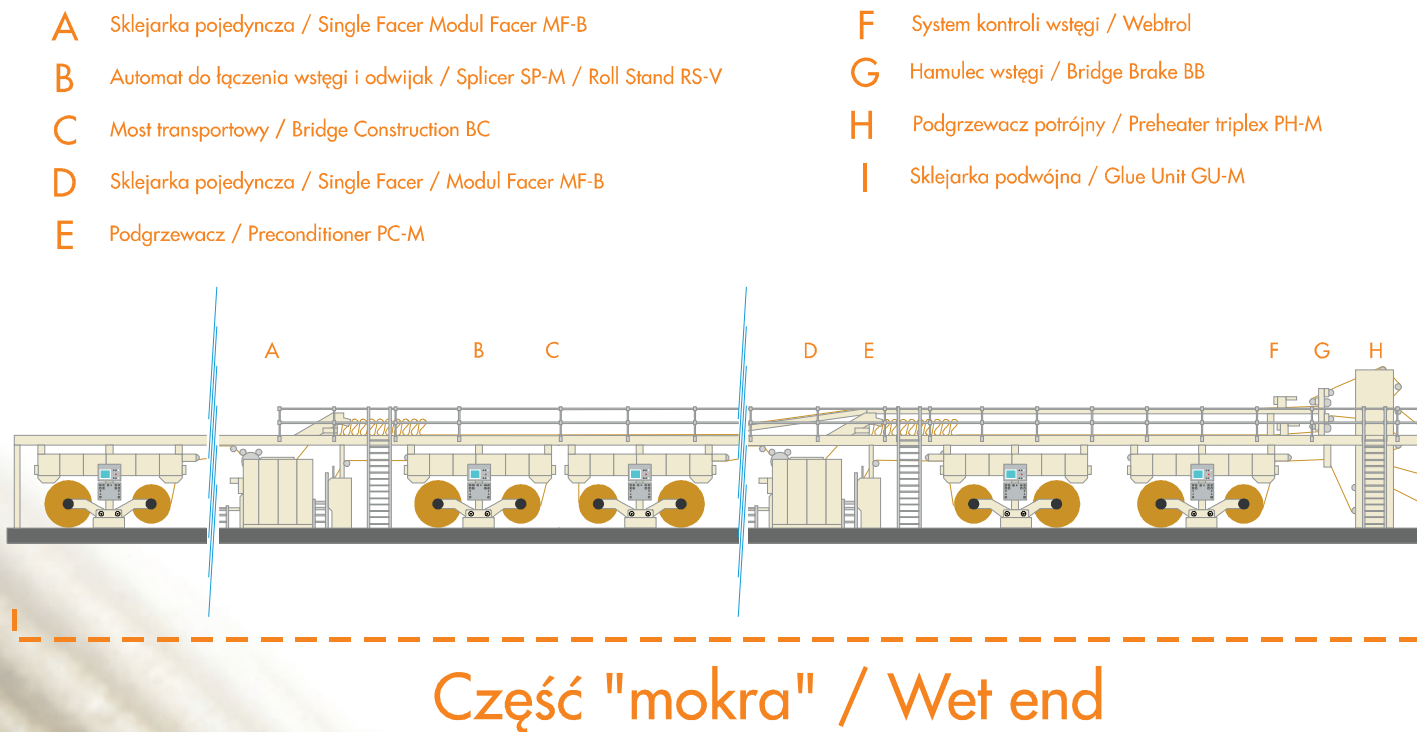


Fig. 9. Corrugator – “wet end”

Board sheets, which have been cut into the required sizes, are then transported by belt conveyers to a machine piling them into evenly arranged stacks of the requested number of sheets. Such prepared sheets may be piled on the pallets for immediate sales or may be further processed into packagings.

The most popular and applied corrugator equipment which provides value added include:

preprint cutting systems enabling synchronous cross-cutting of the preprinted fluting web in the designed position. The received printed board (usually with a multicolour high quality imprint) is mainly used for high volume production,

tape application systems: tear-off, reinforcing and sealing tapes, which add new functionalities to packagings made of the corrugated board. These include: quick and easy opening, local break preventing reinforcement, e.g. handle reinforcement tapes, or protection against an unauthorised opening,

coating systems for paper of board web: coating with waxes, lacquer, inks or other preparations, which increase board resistance to moisture, grease and other substances.

Modern corrugators, which in production of double-faced corrugated board reach speeds over 300 m/min, are equipped with automatic splicing systems. They are co-

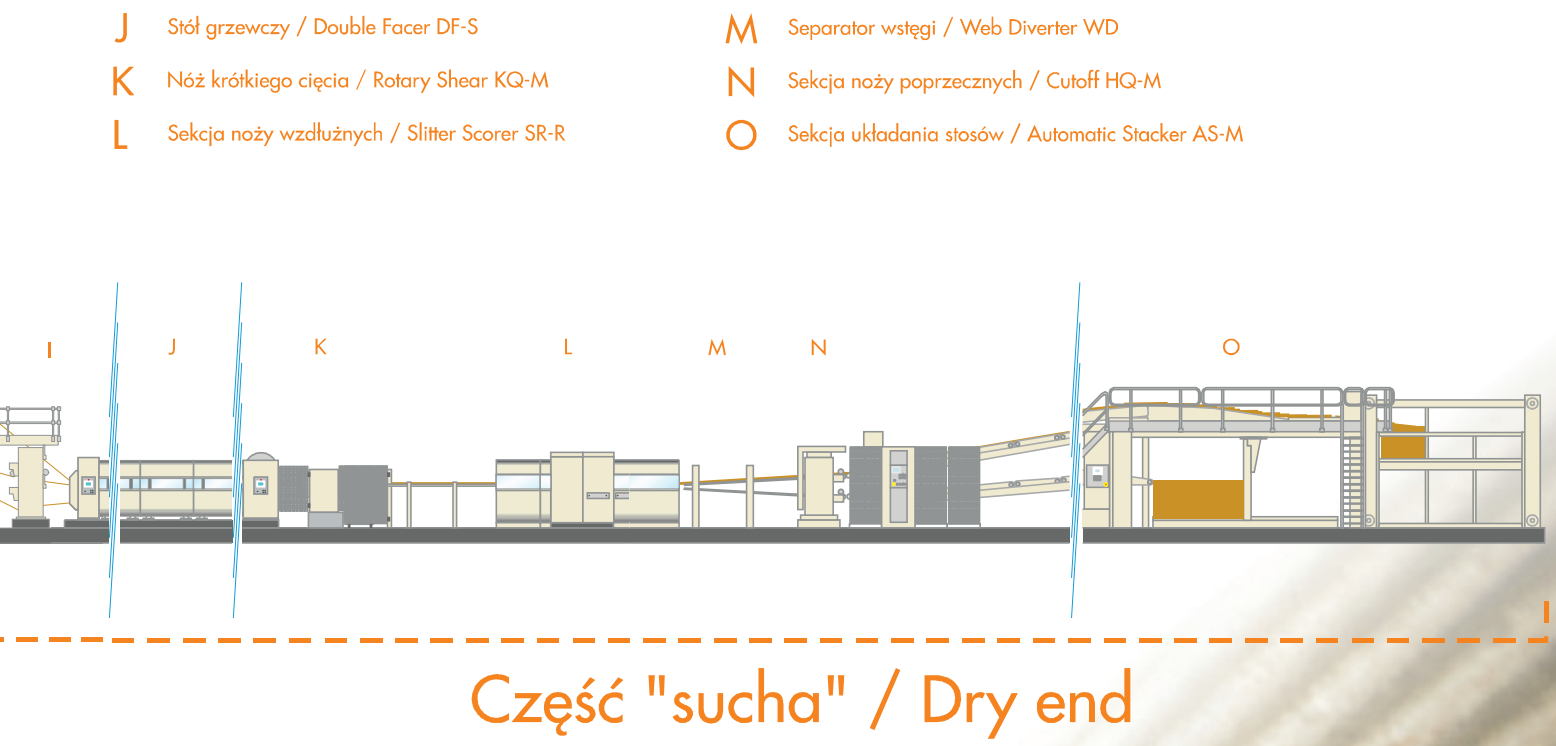


Fig. 10. Corrugator – Dry end

upled with paper reel unwinders, and they allow for the reel change without stopping or significantly slowing down the machine; they also considerably reduce the amount of scrap.

Moreover, the modern corrugators have additional systems improving their effectiveness and facilitating maintenance and control, which enhances the quality of the product. The installed computer systems allow for a far reaching process automation, ensure maximum reproducibility, reduce scrap and energy consumption. Frequently they are interlinked with the integrated company management systems, which allows to reach and exceed annual production capacities – 100-200 mill. m^2.

5. Corrugated board packagings – classification

Conversion is a term traditionally applied for a group of processes where the corrugated board is processed into packagings. Packagings made of the corrugated board may be divided into different categories, depending on their construction, manufacturing process and application.

a. Classification according to the packaging construction

The most common packages made of corrugated board are flap boxes, also known as traditional, American box, American standard, RSC (Regular Slotted Container) or FEFCO 201.

These are one-piece formed packagings, which may be produced of all types of corrugated boards. They are manufactured on automated lines (inliners or flexo folder gluers), where in a single–pass of a properly prepared corrugated sheet the processes of printing, cutting, folding, gluing and stacking are carried out. These packagings, thanks to the application of the optional equipment, may be modified by using additional die cut elements. Moreover, forming may be reinforced with staples or a tape. Flap packagings may also be produced on simpler autonomous machines performing individual operations. Such processes are less effective and more labour-intensive.

Another type of packagings are die cut boxes, also known as the shaped or sophisticated packagings. They are produced as sized packagings and as box blanks.

This group contains many various designs of closed packagings (boxes) and open packagings (trays). These packagings form subsequent subgroups, according to their filling, or manual or automated forming, etc. The common feature of this diversified group is their manufacturing with a die.

A die is a tailor-made tool for a particular packaging. It is a laser-cut plywood, covered with rubber dampers and ejectors, with slotting, creasing and perforating knives. Such tool may carry out the complete processing of the corrugated sheet. Machines producing die cut packagings are called slotters.

Depending on the machine construction die cutting can be done on either flatbed or rotary presses.

b. FEFCO classification

There are several standard classifications of packagings. Most frequently the FEFCO (European Federation of Corrugated Board Manufacturers) catalogue is used. FEFCO code is a four-digit symbol, e.g. 0201, specifying the design of a packaging.

FEFCO classification:

- Commercial rolls and sheets (0100),
- Slotted-type boxes (0200),
- Telescope-type boxes (0300),
- Folder-type boxes and trays (0400),
- Slide-type boxes (0500),
- Rigid-type boxes (0600),
- Ready-glued cases (0700),
- Interior fitments (0900).

Commercial rolls and sheets are labelled with code 0100.

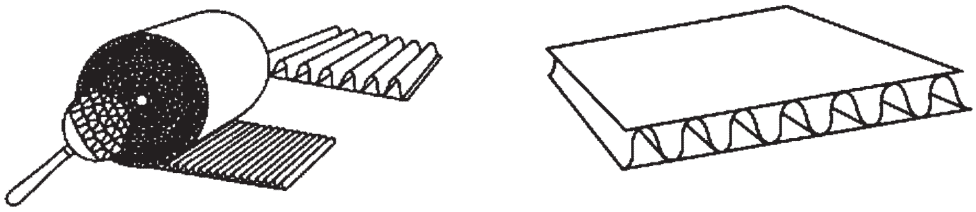


Fig. 11. Corrugated board sheets – examples

Slotted-type boxes (code 0200) normally consist of one piece with a sized, stitched or taped manufacturer's joint and top and bottom flaps.

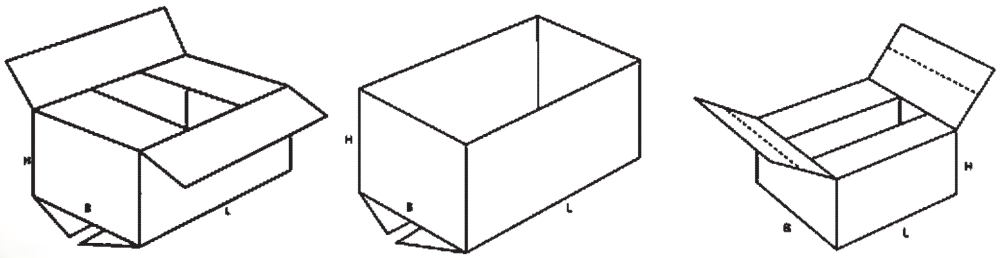


Fig. 12. Slotted-type boxes – examples

Telescope-type boxes (code 0300) Telescope boxes usually consist of two or more pieces and are characterized by a top piece (lid) fitting over a bottom piece (bottom) or both fitting over a separate body.

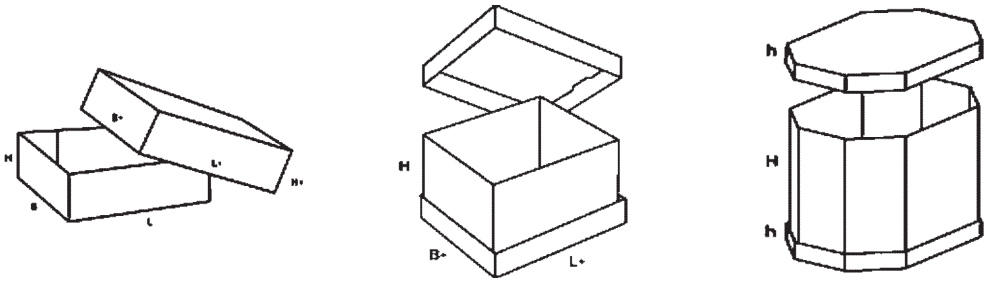
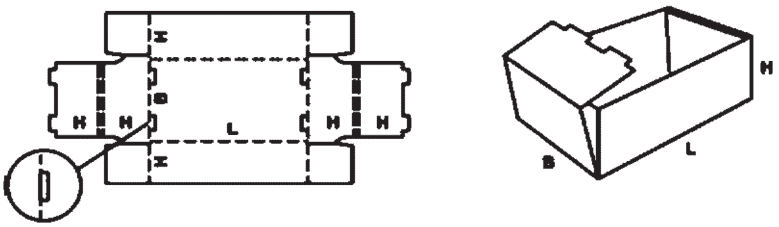


Fig. 13. Telescope-type boxes – examples

Folded-type boxes and trays (code 0400) Folding type boxes and trays usually consist of only one piece of board. The bottom of the box is hinged to form two or all side walls as well as the lid. Locking tabs, handles, display panels etc. can be incorporated in this design.



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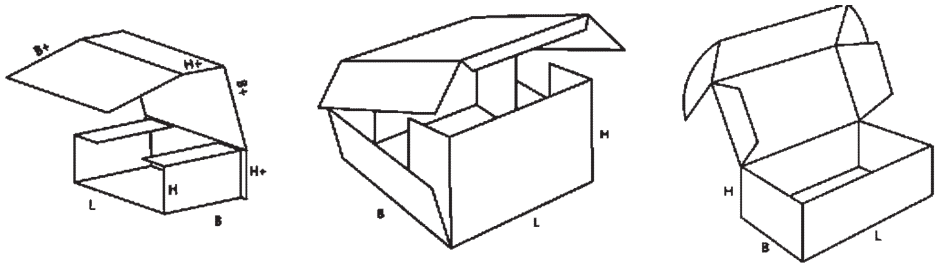

Fig. 14. Folded boxes and trays – examples

Sliding-type boxes (code 0500) consist of several pieces of liners and sleeves sliding in different directions into each other. This group also includes outside sleeves for other cases.

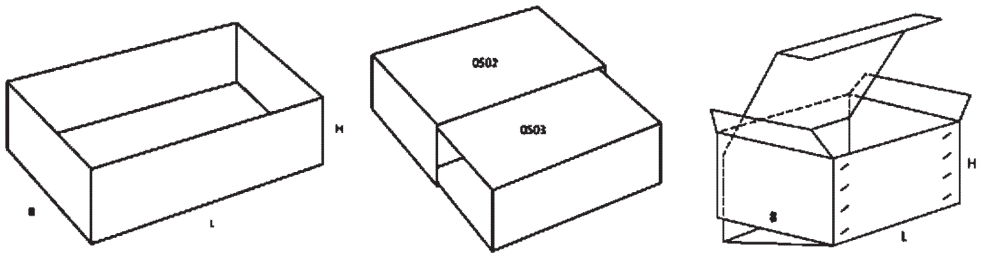

Fig. 15. Sliding-type boxes – examples

Rigid boxes (code 0600) Rigid boxes normally consist of two side elements and a middle part that is bottom as well as the lid in one . These boxes can be delivered as individual units and have to be joined with the help of clamps.

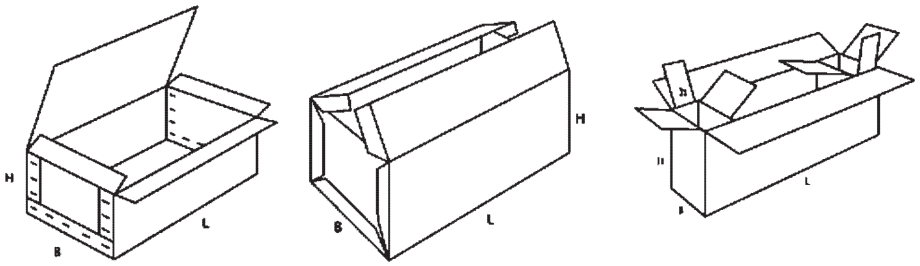

Fig. 16. Rigid boxes – examples

Ready glued boxes (code 0700) one piece telescope boxes which are shipped flat and ready to use by simple setting up. The boxes can be provided with a folding bottom (folding bottom box) or with a diagonal bending (erectable box).

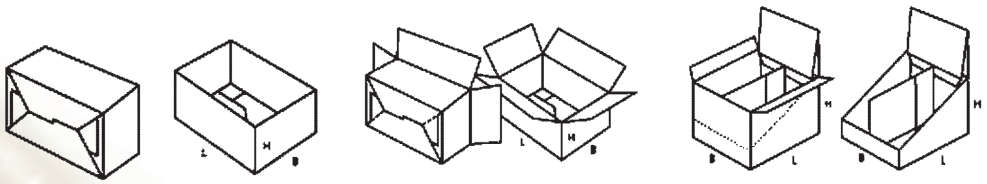

Fig. 17. Ready glued boxes – examples

Interiors (0900) such as inserts, dividers and partition walls can either be attached to the box or loose elements. The number of elements are variable.

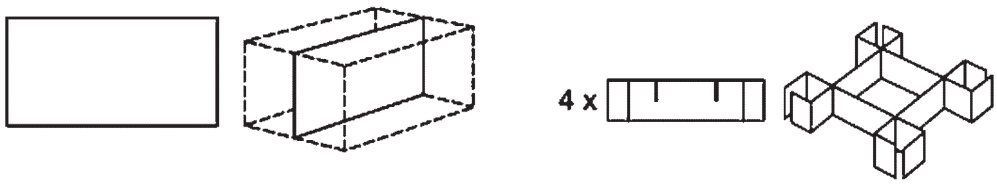

Fig. 19. Interiors – examples

c. Special packagings SRP (Self Ready Packaging)

SRP (Shelf Ready Packaging)

SRP packagings are constructed to be used at shop shelves. Shelf ready packaging has become an important element of the market game and a more and more frequently used tool in brand marketing.

SRP must satisfy the following criteria:

- **easy identification** – which enables quick recognition of the content. The packaging provides essential information necessary for the contained product: product name, bar code, number of units, weight and validity. Thus the brand and the product are presented in transparent and orderly manner;
- **easy opening** – the SRP opening instruction should be placed in a visible place and in a graphic form. Easy opening facilitates work of staff responsible for the display of goods in a shop. No knife or other sharp tools are needed for opening the packaging. It may also have handles or carrying holes;
- **easy shelf arrangement** – SRP have standardised dimensions, which are in close correlation with the size of the rack where they are displayed. This allows for an effective use of the shelf space, while the product arrangement process is simple and easy. The SRP packaging – even after a removal of part of its content – maintains stability and allows for an aesthetic display of the products;
- **easy sales** – an important feature of the SRP packaging is its aesthetics and comfort. Packagings are designed to attract customer attention and encourage people to buy the displayed products. They must not only protect the product, but also perform the marketing function. The SRP packaging should also offer an easy access to individual products, which in turn should build customer loyalty.

- **easy disposal** – SRP packagings are also designed for an easy disposal. If disposable, they are usually made of a single type of material. Often, the SRP packagings are reusable.

Bag-in-Box

Bag-in-Box packagings are used in the food, pharmaceutical and household chemistry sectors, for packing fluids and semi fluids, mostly between 2 and 1000 litres. Bag-in-Box consists of and inner packaging – usually a multi-layer PE bag with a closure and an outer packaging – a corrugated board box. These systems are used in the food and industrial sectors, where the prolonged product validity and preservation is essential.

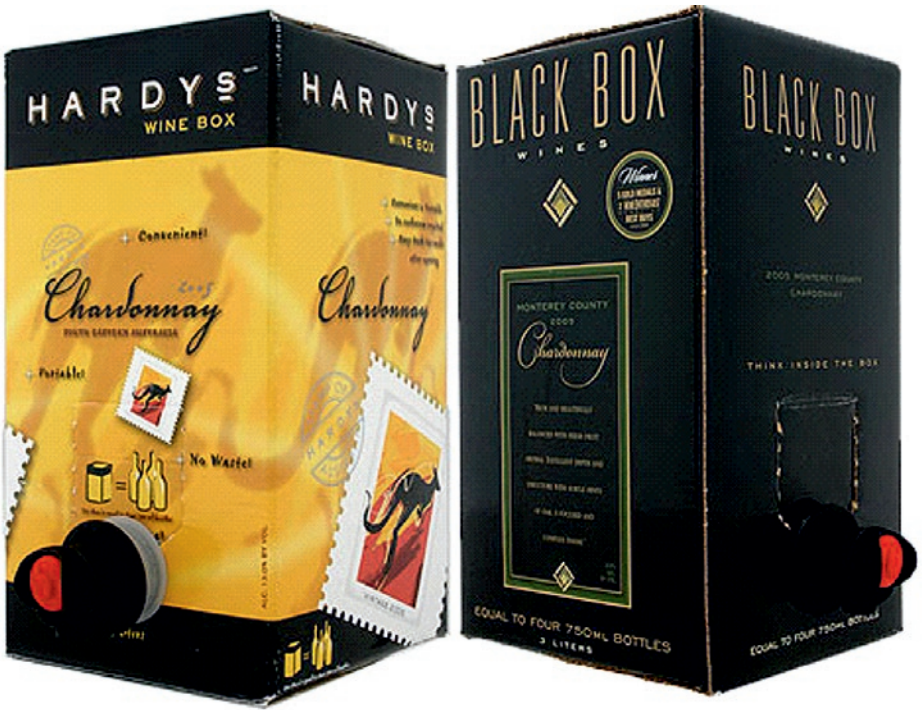

Fig. 19. Bag-in-box– examples

Display and POS (Point of Sales)

Display or POS (Point of Sales) packagings play mainly marketing and display role. Application of an effective construction combined with the attractive graphics increases the noticeability of the product at the point of sale.

Fig. 20. Display and POS – examples

6. Production process of corrugated board packagings

a. Production process of slotted-type boxes (RSC)

Machines for the production of slotted-type boxes (inliners or flexo folder gluers) are built of the modular sections, configured according to the expectations of individual market segments, e.g. concerning the number of colours of an imprint or other modifications of the flap box, such as carrying or ventilation holes, windows etc.

A typical construction of an inliners:

- feeder is a section responsible for a synchronous feed of a board sheet into the machine. In the machines with a common drive the main driving engine is also located here. Often the feeder is preceded by the pre-feeder, i.e. a peripheral device automatically passing sheets to the feeder. Pre-feeder allows for higher productivity and eliminates the manual labour.
- flexographic printers. Usually there are several flexo printers in the line. Each may print a single colour. In order to obtain a multicolour imprint we need minimum three colours (Cyan, Magenta, Yellow). Printers in addition to inks may also apply glossy, anti-gliding and other varnishes. For such application however, subsequent units are needed. The main part of the machine is responsible for an even ink distribution on the convex parts of the flexo printing form, called a printing matrix or a film, which mounted on the printing cylinder. Printing forms are made of photopolymers, which in the process of photo-mechanic-chemical processing are mounted to the film and the catches ensuring a secure and precise assembly in the machine. During the rotation the film meets the horizontally passing board sheet, leaving an impression of the convex elements, while the concave parts leave the remaining sheet unprinted. Anilox (a raster roller) is responsible for an even distribution of ink on the film. Anilox is usually covered with a ceramic layer which is laser engraved. Anilox surface is a negative halftone screen with the following parameters:
  - number of lines per 1 cm or 1 inch,
  - raster angle,
  - raster volume, cm^3/m^2.

Ink fills the raster ink carriers, while the excessive ink is removed by a rubber roller doctor blades. Printer is equipped with ink unit responsible for the continuous ink circulation during the work of the machine and a mechanical or under-pressure transporters passing the board sheet through the printing process. All elements responsible for

controlling the required parameters, such as pressure, parallelism or roller alignment, have mechanical or computer controlled controls with independent drives.

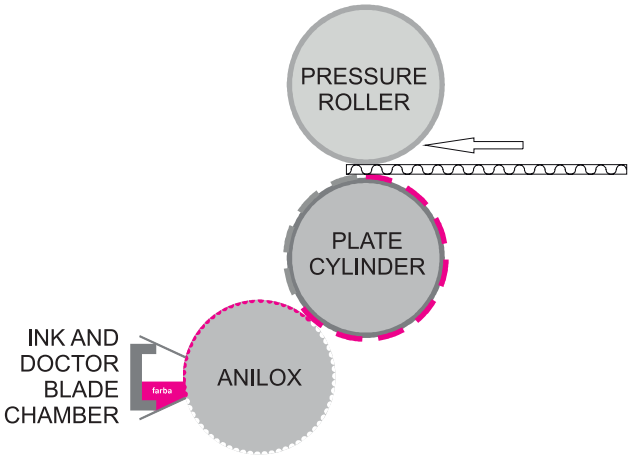

Fig. 21. Diagram of the flexographic printer with the ink and doctor blade chamber

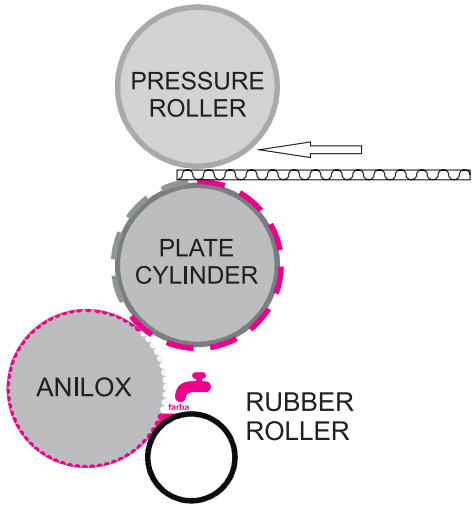

Fig. 22. Diagram of a flexographic printer with a rubber roller

- slotter is a unit which slots the box blank in the corrugated board sheet using the adjustable cutting and bending heads. Elements of this unit cut slots, glued flaps and crease the sheet crosswise.
- rotary cutter is a unit which using a rotary cutting die, i.e. a tool specially developed for a particular packaging, may cut its subsequent elements. Such elements include: handles, inclined or rounded corners of the closing flaps, windows, easy folding bottoms (envelope type) or the tear-off perforations.

A die is a half-round plywood, with steel knives, rubbers and other special elements for corrugated board converting and ensuring scrap ejection.

folder-gluer is a unit where the previously cut blank is folded and glued. A blank is fed to a spider with moving belts, where it is folded to a closed form. In the initial step of the folding process glue (polyvinyl acetate dispersion) is applied on the places to be sized, by the gluer. Optionally the folder may be equipped with a stitching or taping unit.

bundling unit, also called a counter or stacker, is responsible for piling the packagings into the bundles. This is the final section of the machine, synchronised with the speed of the preceding units. It is followed by subsequent devices which bound the bundles with tape in order to ensure stability and fix glue joints. At the end there are simple devices or robots for palletising.

Usually machines are linked to the internal handling system, which - using belt or roll conveyers - deliver stacks of corrugated board to the machine and transport final products.

Modern machines have sophisticated control systems, which – using computer technology – ensure repeatability of the subsequent runs of the same product, using the data base of the machine.

Because of different machine size, machine name may be preceded by a prefix: mini, midi, maxi, and in case of the largest ones - jumbo.

Fig. 23. Machine for production of slotted-type boxes – an inliner (FFG).

b. Die-cut packaging production

Die-cut boxes are produced on the automated production lines, which due to the cutting method are divided into flat and rotary die cutters.

Since the die-cut packagings may be delivered to customers both in the folded form and as flat blanks, the production process is additionally equipped with folder-gluers.

In the lines for manufacturing the die-cut boxes there are two primary types of machines: printers and cutters, which may work together (inline) or may operate independently (offline).

Printers

Flexo printers print on the board (post-print), which then is passed to the die cutters. These machines have: a feeder, printing sections and a stacker. In order to secure high quality and productivity of imprints, such machines are usually set as fixed unmovable printing sections. In the modern machines it is possible to set individual section when the machine is running.

Moreover, the high quality printing (HQP) machines must be equipped with supplementary devices, such as:

- air or infrared dries for drying the printed surfaces,
- underpressure transport unit with independent drives,
- surface cleaning systems at the printer entry,
- online quality control system, with cameras and scanners.

As an option, there may be systems for quick and automated anilox change, providing ink distribution required by a particular design.

Fig.24. An offline Flexo printer

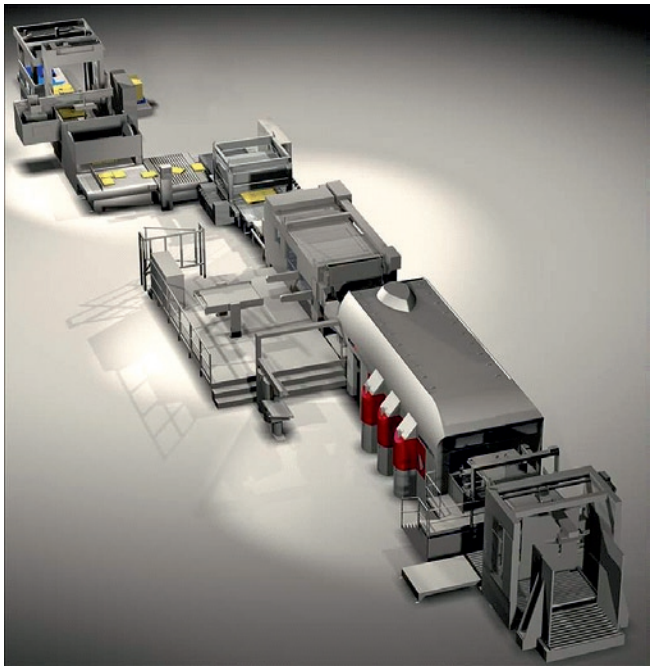

Fig. 25. Inline Flexo printer

Flat die cutters

Flat die cutters use flat dies, cut and bend board sheets, often offering several blanks form a single sheet. The machine die-cuts the sheets by hitting a plated press below a blanking die. Each die is dedicated to a particular product – a packaging.

A blanking die in such machine is composed of the following components:

a proper cutting die, made of laser-cut plywood with the mounted cutting, bending and perforating knives, covered with push-out and damper rubbers,

set of screws and handles for precise and quick mounting,

cleaning unit, called a striper. It is composed of two parts – a top and a bottom one, responsible for the removal of the inside and outside scrap of the blank (the outside scrap appearing at all sides of the blank),

plywood, colloquially called a guillotine, slitting the frontal scrap.

Flat die cutting offers very high blank precision and repeatability, without significant quality drop with the die wear. This cutting technique allows for diversified and complex packaging shapes, while the so called counter-crease provides precisely folding blanks, for processing on customer's folding automated machines. Flat die cutters are also equipped with pre-feeders, breakers and separators of carton blanks.

Fig. 26. Flat Bed Die Cutter

Rotary die cutters

These lines are usually composed of a feeder, printers and rotary die-cutters. Rotary die cutting can cut larger blanks or more blanks than the flat die-cutting, which results in higher productivity and product flexibility. However, this type of blanking has lower sheet cutting precision (higher size tolerance), which to certain extent limits the subsequent use of automated folding machines.

The section which is responsible for removing scrap from blanks is the cleaning section, built of vibrating belts unit and brushes with blowers and exhausters Such design does not require any additional devices for blank cleaning.

The next unit is a blank stacker. There are two versions of stackers. In the first option blanks are directly formed into a stack, thus finalising the production process. In the second option bundles of several dozens of blanks are formed, which then go to blank separating unit, and are stacked.

Fig. 27. Rotary Die Cutter - RDC

Folder-gluers

Multipoint gluers

These machines have extended gluing and folding systems. This allows for gluing in one, two, three, four or greater number of points. Blanks are mostly made on flat die cutters and after passing the feeder they go to the folding unit. Here they are bended and folded while glue is applied to appropriate areas. Folded boxes then go the pressure unit, where - during a pass under the pressure belt (within a dozens of seconds) - the glue joint is fixed. Then the packagings are bundled (manually or automatically) and stacked.

The multipoint gluers are usually used for the production of the three-point glued boxes and four-point glued trays. These packagings are commonly used for mass scale packaging process. Their construction and gluing method enable quick and easy forming.

Single-point gluers

They are usually compact, semi-automated and built on a single machine frame, and their task consists in gluing the blanks with cold and/or hot-setting adhesives. They can also glue two parts of a packaging. This is particularly useful in case of large-size boxes, which (due to the required dimensions) cannot be produced from a single board sheet. A popular option is equipping the machines with a stitching and gluing unit or a separator.

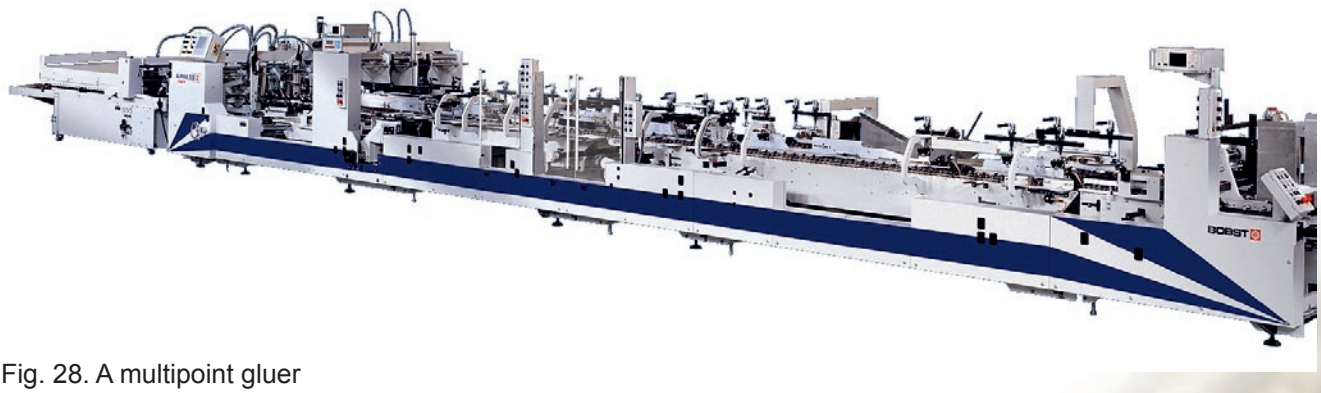

Fig. 28. A multipoint gluer

Offset printing of packagings

Offset printing

"Offset" is a flat printing technique, i.e. the printing and non-printing elements are at the same height in relation to the plate. Image is transferred from the printing form to the substrate with an intermediate cylinder covered with rubber, the so called "printing blanket".

There are two printing methods - web and sheet offset printing.

In case of the web offset paper is fed in reels, and the printing process may use a heatset to fix inks by penetration and evaporation of solvents. This enables printing of coated papers.

Another option is the "coldset", where ink is fixed by paper penetration.

Web offset printing allows for perfecting, when web runs between two intermediate rolls. Machines of this type are usually equipped with a unit for cutting and folding paper into a folded sheet.

Typical final products of the heatset machines are multi-colour magazines printed on LWC or S.C. papers, while coldset is used for newspapers.

In the sheet offset - board sheets serve as printing base. It is one of the most popular printing techniques, enabling accepting even very small orders. Usually the sheet printing machines print one side of the paper, however a second paper pass is also possible. Special equipment may also be installed, the so called perfector, which enables automated sheet reversing and perfecting. Sheet is transferred by transport suckers, which hold the leading edge carry the sheet along all printing units, up to the sheet delivery section.

In offset a printing form, known as a plate, is a thin aluminium sheet with hydrophilic elements damped with moistening agent, and hydrophobic or oleophilic elements, damped with printing ink. Moistening solution is composed mainly of water and additives which decrease surface tension, as well as stabilizers, maintaining the adequate range of the solution's pH. Isopropyl alcohol (IPA) – a substance harmful both for the environment and employees – is an important component of the solution. Currently we observe attempts to remove IPA by applying special eliminating buffers.

First, a plate is damped with water, then with ink. There is a process of mutual repellence of ink and the wetting agent. Ink remains only on the plate's oleophilic areas and with the intermediate cylinder - covered with a printing blanket - it is transferred onto the printing base (that is why this technique is called indirect print).

There also is a special variant of the technique called a dry offset, where a silicon printing form is not damped with a moisturising solution. This method is applied mainly on not absorbing substrates. In this manner, similarly to flexography, a monochromatic copy is produced by a single printing unit.

With high quality and possibility of reproducing images of high resolution, for multicolour images it is enough to use the four primary colours (the CMYK triad). Additional colours are added in order to obtain effects exceeding the standard "triad" or special effects, e.g. metallic, reserved corporation colours, etc. Special effect may also be obtain by application of UV inks – fixed by polymerisation initiated by UV rays. This method enables printing of completely non-absorbing surfaces, such as plastics, films, etc.

In offset printing it is also possible to apply high-gloss varnishes and other coatings which improve aesthetics utility of a packaging. Varnish is applied on paper with a printing unit (oil-based varnishes) or with a varnishing tower (water-based varnishes and UV), using a flexographic print.

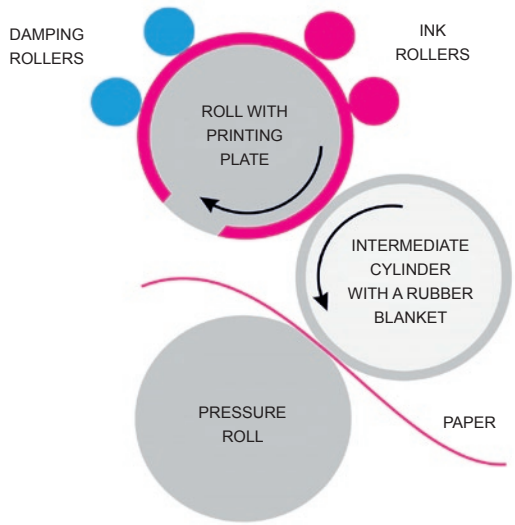

Fig. 29. Diagram of an offset printer

The dynamic development of this technique in the recent years results from the digital image-setting, which reduces the time and improves the quality of the offset plate, and consequently significantly reduces the production costs.

In the technique called CtP (Computer to Plate) image is transferred by the imagesetters directly onto the printing plate, and after image development the printing form is ready. The CtP imagesetters are commonly used even in small printing plants, as the low costs of imagesetting allow for short print runs.

Laminating

Insufficient compensation of uneven surface of the corrugated board during the offset printing prevent application of the method for direct printing. Direct offset printing is only possible on corrugated board with low flute height. However the packaging production technology offers solutions which enable offset printing. Such commonly used solution is lamination, i.e. pasting of the earlier printed paper sheet on the corrugated board. The printed sheets of paper are fixed to the board with glue, most frequently a dispersion of polyvinyl acetate, on machines called laminators. The paper is glued to the single-faced corrugated board in rolls, or to the sheets of board with three or more plies. Subsequent stages of processing of the intermediate product depend on the packaging design and are analogical to the post-printed slitting and/or die cutting of the post-printed boxes.

7. Major properties and parameters of corrugated board

a. Basis weight

Determination of basic weight is based on PN-ISO 536:1996 standard. It is a mass of corrugated sheet of 1 square metre. It is expressed in [g/m^2]. The area of a sample sheet should not be smaller than 100 cm^2 and should not exceed 1000 cm^2. This is one of the basic characteristics of paper product (including the corrugated board). Currently when more and more diversified papers are used, in order to specify board quality it is necessary to test other parameters, e.g. ECT. Tolerance interval for basis weight is ±4%.

b. Edge crash test (ECT)

ECT test is performed in accordance with PN-EN ISO 3037:2000 standard. Undoubtedly the edge crash resistance is one of the major characteristics of the corrugated board. Edge crash strength is expressed in [kN/m]. In different parts of the globe different ECT tests are carried out, however the most common is the below described “unwaxed edge method”.

Testing principle: A rectangular sample of corrugated board (25 mm ±0,5 mm parallel to the flutes and 100 mm (±0,5 mm) perpendicular to the flute orientation) is placed between two plates, and is put to cramping pressure test until the sample crashes. Maximum pressure withstood by the sample is measured. This parameter is usually an important additional characteristic presented in corrugated board specification in commercial offers and in packaging specifications. Tolerance interval - ±10 %.

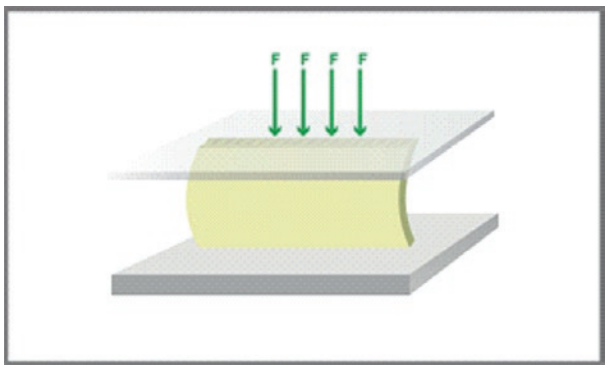

Fig. 30. ECT test

c. Flat crash test (FCT)

The FCT test is carried out on the basis of PN-EN 23035:1999 standard. This method of testing flat crash resistance is suitable for two or three-ply corrugated boards. It not used for board with more plies.

The testing method: A sample, cut of corrugated board, is subjected to increasing pressure, applied perpendicularly to the surface, until the corrugated medium is crashed. Maximum force withstood by the sample is measured.

Flat crash resistance is expressed in [kPa] (maximum pressure to the sample surface).

Test results depend on the flute type and the corrugated medium properties. The test is applicable wherever it is important to know the characteristics of this ply of the corrugated board. Tolerance interval for this parameter is ±10 %.

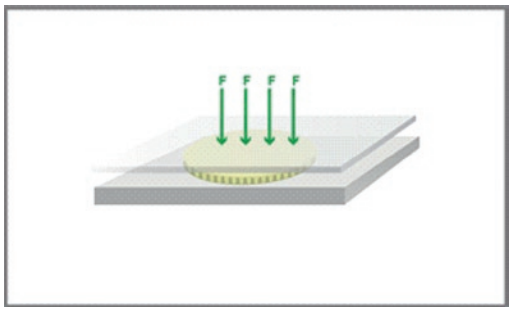

Fig. 31. FCT test

d. Bursting strength

Test is performed in accordance with PN-EN ISO 2759:2005 standard. Bursting strength specifies the maximum pressure produced by the hydraulic system pushing a rigidly clamped flexible round diaphragm on the sample, causing its burst. Bursting strength is expressed in [kPa].

The burst index – is a ratio of board bursting strength to the basis weight of the board, determined in accordance with ISO 536:1996

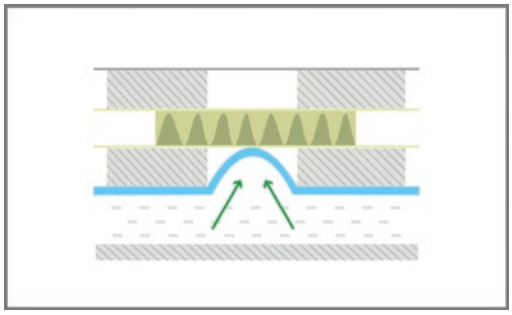

Fig. 32.Burst test

This parameter is strongly dependent on paper type used for liners. Papers made of primary fibres have much higher burst index than the papers and boards made of secondary fibres (recovered paper). Tolerance interval is ±10 %. Frequently, also the minimum value is specified.

e. Puncture resistance test (PET)

The test is based on ISO 3036:1975 standard. The test consists in measuring the energy required for an effective puncture of a board sample with a head, which should be a triangular pyramid. This method is applicable to all types of corrugated board. The sample should not be smaller than 175 mm x 175 mm. Puncture strength is expressed in [J].

This test is a perfect tool for evaluation the risks a packing may be subject to in the logistics chain. Tolerance interval for the parameters is ±10 %.

f. 4-point bending stiffness

Test is carried out in accordance with ISO 5628:1995 standard. It specifies the bending moment per width unit, shown by the corrugated board when bended within the limits of the elastic strain. The 4-point bending stiffness is expressed in Newton-metres [N*m].

This is one of very few methods for measuring the deterioration of board strength in the conversion process. Tolerance interval for the parameter is ±10 %.

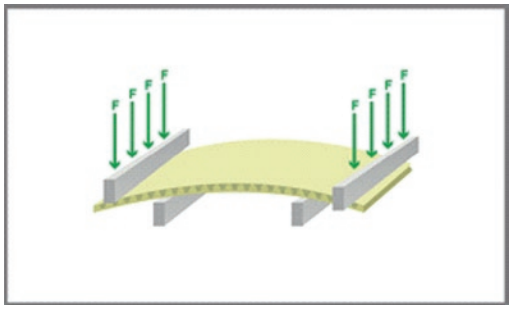

Fig. 33. Bending stiffness test

g. Water absorption (the Cobb test)

The test is performed in accordance with PN-EN 20535:1996 standard. The test allows for the evaluation of water absorption by the corrugated board. Mass of water absorbed within a specified time by 1m^2 of board in specific conditions, is a measure of water absorption in COBB units. The testing time depends on the type of board and is within the range between 30 s – 1800 s, while the result is presented with a time index.

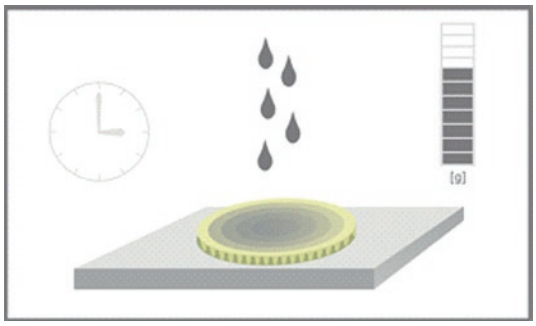

Fig. 34.Water absorption test

Water absorption determines applicability to a certain converting processes (e.g. printing) and properties e.g. resistance to the changing atmospheric conditions. In most cases the maximum acceptable parameter tolerance is specified. Usually it is within 30-60 grams per square metre.

h. Moisture content

Moisture content is tested in accordance with PN-EN ISO 287:2009 standard using a chamber dryer. Moisture content in the board is specified as ratio of sample mass reduction after drying to the initial sample mass, usually expressed in [%].

This is an essential parameter to measure. Moisture content of the corrugated board translates directly onto its resistance properties and applicability to processing. It influences the dimensional stability of the board and packagings thereof. Tolerance interval for the parameter is ±2 % of the nominal value.

i. Flexion of corrugated board (flatness)

Flexion is defined as the ratio of the sheet bend height (N) to the sheet length (L). It is expressed in [%]. It should not exceed 4%.

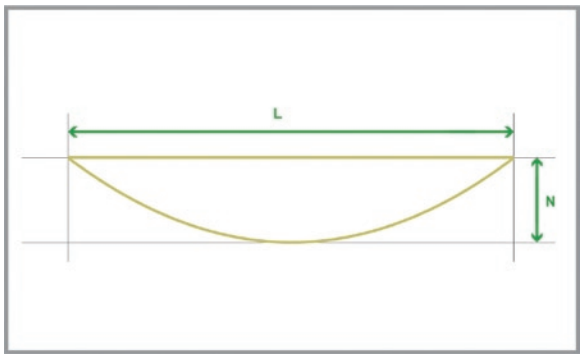

Fig. 35. Corrugate board flexion
where:
I= flatness, %
N – maximum bow height mm
L – sheet length, mm (default 1 m)

This factor is particularly important in case of boxes (blanks) for machine packaging.

j. Colour of corrugated board

The colour of the corrugated board is not unequivocally specified. It is assumed as “characteristic for paper products” and should be the same at least within a single production run.

8. Major properties and parameters of packagings

Strength parameters

The basic and the most frequently used measure of strength of the corrugated board packaging is the box compression test (BCT).

The parameter is determined in order to measure the box resistance to loads caused by compression and stacking. The test consists in compressing a box between two parallel plates, until the walls crash. Test is carried out on empty containers, after they have been properly formed and glued. The resistance is tested for vertical, lateral and longitudinal compression. Resistance level in case of the lateral and longitudinal compression is not as high as for the vertical compression (PN – EN ISO 12048:2002)

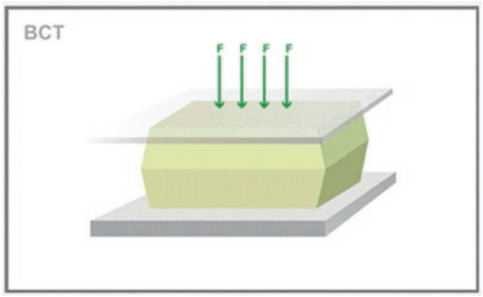

Fig. 36. BCT

Boxes made of the corrugated board should ensure an adequate protection of the content during the entire cycle of packaging and distribution. The fulfilment of this task depends on the quality of board used and the workmanship. The check-list presented in Table 3 often serves as an example of a required specification.

Item number	Parameter
1	Internal and external dimensions of a packaging
2	Packaging construction: - Fefco no. - according to the enclosed drawing - according to the enclosed design
3	What is the product or the primary packaging and can they carry loads
4	Joining method - glue - stitching + gluing - stitching - not applicable
5	Board type: 3- or 5-ply - two-sides white - one-side white - two-side grey
6	Flute type
7	Weight of the packaging content
8	Number of layers on a pallet
9	Are the pallets to be stored one on anther? Yes/No
10	Will the goods be stored in cold store? Yes/No
11	Pallet type EURO/disposable
12	May pallets jut out of the pallet? Yes/No

Table 3. Check-list

b. Other packaging tests

Applied for instance in case of special testing programmes applicable to packagings for dangerous materials.

Dangerous materials should be stored and transported in special quality packagings, in order to withstand vibrations and loading operations during their transport. Packagings should be made and closed in a manner preventing any loss of their content in transport, due to vibrations, temperature changes, humidity or pressure. Each dangerous material should be packed in such type of packaging which is certified by an applicable packing instruction and stipulated in the relevant regulations.

The basic program of tests for certified packagings (legal requirement for dangerous material packagings) include:

- drop test,
- horizontal impact,
- static pressure.

c. Dimensioning

- There are three types of packaging dimensions:
- inside,
- outside,
- constructional.

Dimensions are always given in the following sequence: length, width, height and as a standard they apply to the box interior. These are the inside utility dimensions.

Inside dimensions of a packaging (length and width) are distances between two opposite walls of the formed box. Height is a distance between the inside flaps forming a bottom and the top (lid).

We should stress that measurements must be made in the nearest places (which guarantees that the inside dimensions are at least equal to the dimensions of the packed product).

If other than the inside dimensions are given, it should be clearly and expressly stated – for example outside dimensions, which are the overall dimensions of the packaging.

Moreover there a constructional dimensions, which appear in designs (2D), sent for the approval. This type of dimensioning does not include the material thickness and is identical to the axis of the box constructional walls.

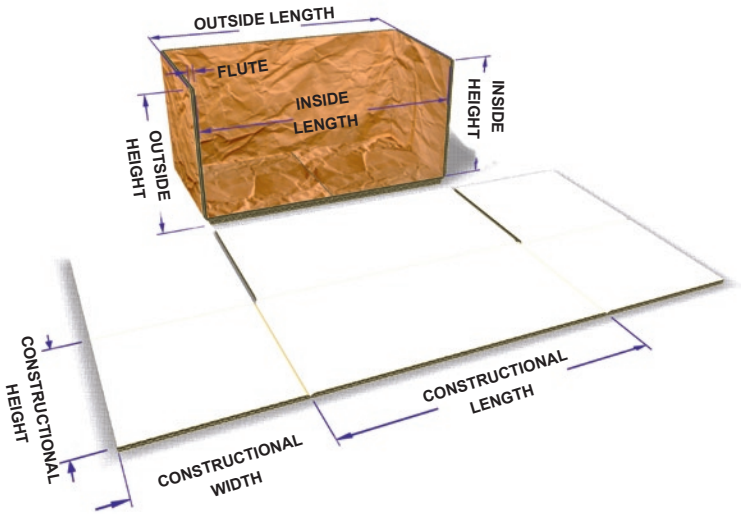

Fig. 37. Box dimensioning

d. Tolerances resulting from the technical capacities of the converting machines

- BCT tolerance ±10% of the nominal value,
- Inside dimensions tolerance ±2 mm,
- tear-off strip arrangement ±2 mm,
- crease spacing ±2 mm,
- fishtail

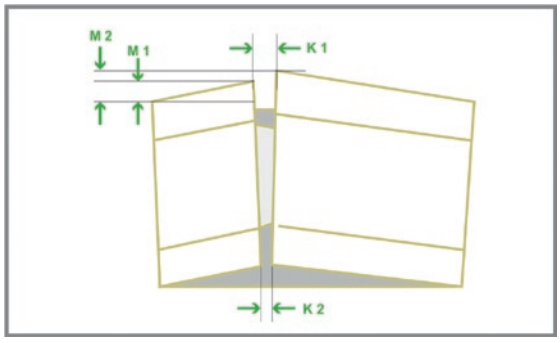

Fig. 38. “Fishtail”

The term “Fishtail” is used for lack of parallelism between the edges on the joint side / at the glued flap.

Distance variations (K1-K2), presented in Figure 38, depend on the flute type and should not exceed:

- B flute: 4,5 mm,
- C-A flute: 6,5 mm,
- AB-CB flute: 8 mm.

Colour of packaging

For packagings with white liner it is possible to specify the whiteness. For the so called “brown” packagings colour is not specified and should be treated as characteristic for the paper industry products. Possible colour variations are acceptable.

Volume tolerance – number of packagings or sheets

A buyer should accept the delivered packagings or sheets, in accordance with the following tolerances:

- ±20% <500 pieces of packagings or sheets
- ±10% 501 - 2000 pieces of packagings or sheets
- ±5% 2001 - 4000 pieces of packagings or sheets
- ±2% >4000 pieces of packagings or sheets.

Warranty

A warranty may cover one year both for packagings made of cellulose paper and of recovered paper, calculated since the production date, excluding the imprint, subject to keeping adequate storage and transport conditions.

9. Packaging, storage and transport standards for packagings

Packing

Supplies of packagings to external or customer's warehouses should take into consideration the climate and transport conditions, which may affect product quality (packaging, corrugated board).

Adequate pallets must be used for storage and transport of packagings. Packaging must be placed on a dry pallet, protected with an additional sheet of board. Pallet height should be adjusted to the storage and transport requirements. A standard height of goods with a pallet is in the range 1800 mm - 2200 mm, depending on the producer's and/or customer's conditions.

In order to prevent draftage in transport, pallet tapes are used. In certain cases in addition to tapes, it is also possible to use shrinkable pallet covers. Proper protection of goods for transport is required for the maintaining of packaging quality.

Storage

In order to maintain the quality of packagings at a constant level, they should be stored in accordance with the general recommendations for storage of corrugated board packagings. The major recommendations include:

- Storage of packagings in properly ventilated premises, where the temperature and the relative humidity are respectively 5–30°C and 30-70%. Rapid changes of temperature or humidity in stores must be prevented;
- Storage not directly on the floor but on pallets or platforms, on clean and dry surface;
- Protecting packaging against water (rain, condensation, leaks) and excessive direct sun operation. Packagings must not be splashed with water when handled;
- Protection against dust, which may be damaging for packing machines;
- Protection against heat and rapid changes of climatic conditions (frequently opened doors, adverse effects of ventilation systems, etc.);
- Ensuring appropriate movement of packagings – the FIFO principle "first in / first out";
- Maintaining packagings in the condition in which they arrived, without removing protective devices until their release;

Refixing the protective film and straps after part of the packagings were taken away from the pallet. When refixing the wrapping, attention must be paid to avoid damaging

the packagings. Damaged packagings may lose their functionality as well as they can block lifting or packaging equipment;

Avoiding high vertical storage of pallets. In certain circumstances this may damage packagings placed on the bottom pallet;

Cautious use of sharp objects (knives, etc.) for opening pallets or wrapping removal. This may damage the packagings;

Keeping all ID documents on the pallet until all the packagings are used.

Implementation of the above recommendations has a positive impact on the utility of the products.

Transport

Adequate transport of the board packagings to an external store significantly affects their quality. There are the following types transport:

- road transport,
- by rail,
- by water (inland water or by sea),
- by air.

Safeguard should be adjusted to the type of transport. In case of road transport of carriage by rail or by air, special attention should be paid to protection against mechanical damages. In water transport there is an additional risk resulting from humid air and wetting of packaging. Also the cleanness of means of transportation is important (odour, dust).

In all the above mentioned cases we should apply exactly the same safeguards as in storage.

10. General introduction to standards for corrugated board packaging used for food

There are not any specific directives or binding regulations on the EU single market, which are applicable to packagings made of corrugated board and which are used in direct contact with food (at least until the publication of this paper). Producers of such packagings may apply standards related to food safety. Thus, for the production of packagings made of the corrugated board and intended to come into contact with food, it is recommended to apply one or several of the following standards:

- GMP and GHP,
- HACCP,
- PN-EN ISO 22000:2006 with additional specification PAS 223:2011
- BRC, particularly chapter “Global Standards for Packaging and Packaging Materials”, 2011
- IFS.

a. GMP (Good Manufacturing Practice) and GHP (Good Hygienic Practice)

GMP/GHP book contains a set of guidelines on good manufacturing and hygienic practice. It has been based on:

- Guidelines of the World Health Organisation of “Codex Alimentarius”,
- Regulation (EC) No. 1935/2004 of the European Parliament and of the Council of 27 October 2004 on materials and articles intended to come into contact with food,
- Regulation (EC) 2023/2006 of the Commission of 22 December 2006 on good manufacturing practice for materials and articles intended to come into contact with food,
- Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety,
- Regulation (EC) No 852/2004 of the European Parliament and of the Council of 29 April 2004 on the hygiene of foodstuffs.

It is suggested that GMP should be adopted as the recommended standards to be also applied by the manufacturers of packagings made of the corrugated board. In particular, GMP contains guidelines concerning the following issues:

- plant location,
- buildings, constructions, production, storage and communication facilities,
- plant, equipment, accessories,
- raw material supplies and oversight of suppliers,
- assessment, receipt and storage of raw materials/ production components,
- water supply and sewage management,
- manufacturing process,
- internal storage and transport of the finished goods,
- maintaining cleanness in and out of plant,
- pest control,
- waste management,
- requirements for employees, visitors and contractors,
- glass management,
- personnel training.

b. HACCP (Hazard Analysis and Critical Control Points)

HACCP is system of hazard analysis and critical control points. It consists in system approach aimed at identification and estimation of the scale of hazards to the food safety, from the point of view of its health quality and risks during all production and distribution stages. It is also a system aimed at specification of methods of risk mitigation. The HACCP system gives certainty that the plant fulfils all the requirements concerning product and consumer safety, in respect of regulations, principles of good manufacturing practice and customer's needs.

Obligation of HACCP implementation in all companies of the **food industry** was introduced with the Polish accession to the European Union on 1 May 2004.

The HACCP system is based on the following seven principles:

1 – Hazard identification and development of preventive measures,

2 – Identification of critical control points (CCP),

3 – Establishment of critical limits,

4 – Monitoring of the CCP,

5 – Establishment of corrective measures,

6 – Verification procedures,

7 – Record keeping.

The HACCP system may be used in the sector of packagings made of corrugated board.

c. PN-EN ISO 22000:2006

ISO 22000: 2006 is an international standard, combining the requirements of the HACCP (consistent with Codex Alimentarius) and Good Manufacturing And Hygienic Practice. The requirements of the standard are applicable to companies of any size and production profile.

The ISO 22000: 2006 standard is a document containing the requirements concerning not only its implementation, but also, its operation and development of the management system, aimed at supplying safe food to the customers.

This standard is an up-grade of the existing food safety system into a typical management system, based on ISO 9001. It is addressed to organisations directly and indirectly participating in the food chain, especially to the food producers, manufacturers of food additives, distributors (warehouses, wholesalers), producers of machines and equipment, catering companies, traders, hotels, transport firms, packaging producers, breeders, planters, service providers (e.g. hygienic services).

The standard is compatible with ISO 9001: 2000 and ISO 14001 environmental standard, which facilitates its integration with the already existing company management systems. Implementation of the ISO 22000:2006 standard automatically introduces the HACCP system to the company.

d. BRC (British Retail Consortium)

BRC is a set four industry technical standards, which specify food safety requirements in the process production, packaging, storage and distribution. Initially developed by British Retail Consortium, BRC is used around the world by retailers and producers of well-known brands, but most popular is the EU and North America. There are four types of standards:

- Global Standard for Food,
- Global Standard for Consumer Products,
- Global Standard for Packaging and Packaging Materials,
- Global Standards for Storage and Distribution.

e. IFS (*International Food Standard)*

IFS has been developed for auditing the suppliers of the so called “own brands” to commercial networks, who are audited in accordance with the IFS standard.

IFS specifies the following requirements:

- Company environment, both external (location and environment), and internal (rules of procedure, equipment, surface condition – walls, ceilings, windows, etc.),
- rooms,
- waste management,
- pest control,
- transport,
- product, including its design and development,
- control allergens, metals, packagings,
- critical product safety analyses,
- product approval and identification of incompatible products.

Summary

Paper, corrugated board and packagings do not appear on any specification of the prohibited materials and generally are suitable for direct and indirect contact with food. While a thorough examination of the requirements they have to satisfy, results in a long list of major risks, which may disqualify them from contact with food. This is a duty of the producers to specify the terms of their application, taking into consideration the type of food, conditions of packagings and storage.

The corrugated board packagings produced in compliance with the above systems, should not be treated as guaranteeing food safety in case of their direct contact with food.

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