UDC 655.621.798

© S. Havenko, PhD, professor, V. Bernatsek, dr. eng., Associate Professor, P. Ryvak, dr. eng., Associate Professor, Labetska M., dr. eng., assistant, Ukrainian Academy of Printing, Lviv, Ukraine

INVESTIGATION OF QUALITY OF PACKAGING MADE OF LAMINATED MICRO-CORRUGATED CARDBOARD

The reproductive and graphic indicators of liners printed by offset printing are investigated in this work. It was considered the process of their laminating to micro-corrugated cardboard using the adhesive device of a new construction with the further determination of the operational parameters of the packaging material. As a result of the research, graphic dependencies were constructed that allow us to assess the quality reproduction of a color image in the offset printing and the operational stability of laminated micro-corrugated cardboard.

Keywords: lamination; micro-corrugated cardboard; fluting; liner; offset printing; imprint.

ISSN 2077-7264. Технологія і техніка друкарства. 2018. № 4(62)

Introduction

Packaging of laminated cardboard, corrugated cardboard and micro-corrugated cardboard is one of the dominant segments of the packaging industry in many countries of the world, including Ukraine. Today, in our country more than 25 thousand enterprises use cardboard packaging for the packaging of their goods [1–3]. The use of laminated micro-corrugated cardboards can improve the performance of the packaging (strength, reliability, resistance to environmental impact), improve its protective functions and aesthetic appearance [4]. In addition, the lamination technology allows you to get high-quality packaging, using at the same time cheap grades of cardboard, which significantly increases the profitability of production.

However, apply a relatively thick (from 1 mm and more) material high-quality offset printing, varnish, embossing is difficult technically, and often due to the specifics of the equipment is simply impossible. But print on ordinary cardboard, then attach to the base of a 2-layer micro-corrugated cardboard is easier. The result of the lamination is a 3-layer micro-corrugated cardboard with a top liner, which is processed by virtually any printing technology — offset and screen printing, UV varnish, hot stamping foil, hot stamping, which complies with the most complicated packaging requirements and continues to be affordable. The process of lamination involves several steps (fig. 1).

Over time, the technology of packaging producing of corrugated and micro-corrugated cardboard has undergone significant changes, since it is environmentally friendly, easy to use, easily print decoration and recycled after use [5–7]. Therefore, it is actual to carry out researches on the process of micro-corrugated cardboard lamination, to determine its qualitative and in particular performance indicators, to develop new and improved existing devices and machines.

The aim of the research

Investigation of the process of making packages of laminated micro-corrugated cardboard; definition of reproduction and graphic indicators of offset printed liners; lamination of micro-corrugated cardboard with the use of adhesive device of a new design; determination of operational parameters of laminated micro-corrugated cardboard (bunching strength and bonding strength, resistance to double buckling) with further investigation of its structure change due to testing.

Objects and methods of research

The objects of the research were the most widespread in the manufacture of packaging materials: offset printed liner (cardboard 'Arctika'), with a grammar of 180 g/m^2, 215 g/m^2 and 250 g/m^2 followed by sample No. 1, No. 2 and No. 3, micro-corrugated cardboard of the brand 311E with fluting with a grammar of 140 g/m^2, adhesive CR of industrial production. A digital color proof with an image of a wide range of colors was printed on an inkjet printer EPSON Stylus Pro 4880; the printing of the analogue color proof was carried out by the inks of the Huber Group of the Resista series (Germany) on the Heidelberg Printmaster GTO 52-2P printing machine (using the thermal plate kit Ipagsa Industrial S.L. (Spain)).

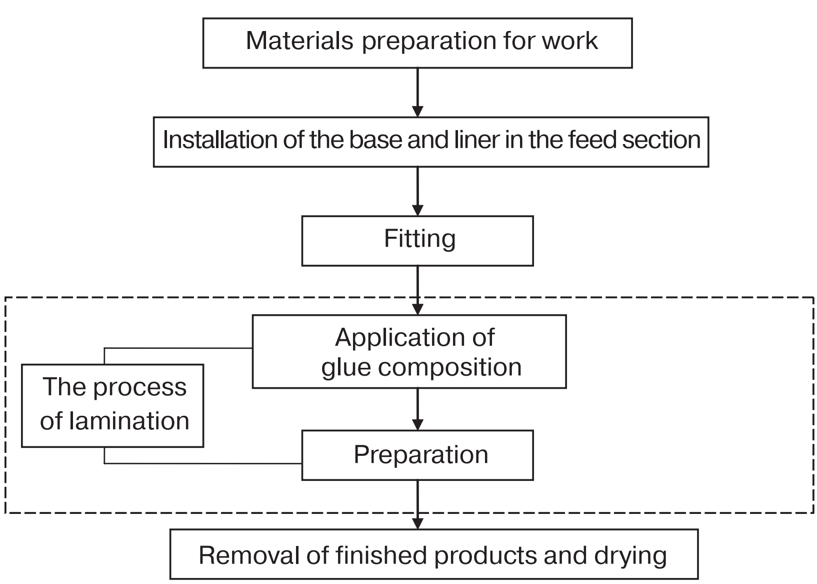


Fig. 1. Diagram of the lamination process

ISSN 2077-7264. Технологія і техніка друкарства. 2018. № 4(62)

ISSN 2077-7264. Технологія і техніка друкарства. 2018. № 4(62)

The conduct of experimental research was carried out in accordance with international standards (ISO 13655; ISO 3664; ISO 2846-2; ISO 12647-2; ISO 12647-4) [8]. The means for evaluating the quality of the imprints were the test scales with halftone fields and tones for CMYK colors, as well as a number of scales for quality control of the offset printing method Ugra/Fogra Digital Print Scale Control, which include elements of sliding, unpacking, reproduction of small parts, radial measure, halftone fields, a combination of colors, text items, etc. The spectrocolorimeter Gretag SPM 50 was used to measure the optical density.

The process of lamination was carried out on the developed device (Ukrainian Patent No. 83440) [9], which includes a new, reliable adhesive device for application of glue directly to the peak of the fluting wave. The adhesive roller is made in the form of a set of two discs of different diameters alternating, and the side wall of the adhesive bath is variable and executed in the form of a comb, which enters into close contact with the disks of the adhesive roller, so that the residual glue is removed from their lateral surfaces. After the cardboard blank is applied, the adhesive is applied with the help of adhesive disks to a uniform layer at the peak of the fluting wave, and the clamping roller prevents deformation of the corrugation.

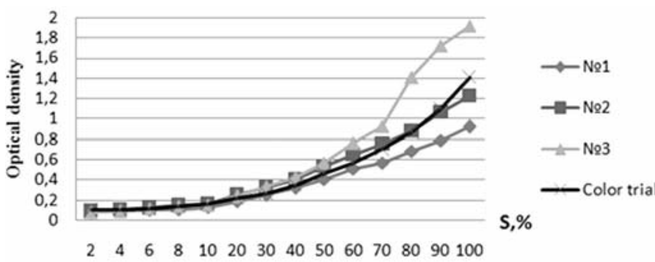
After applying the glue to the micro-corrugated cardboard, the feeding of the top sheet and its combination, the laminated micro-corrugated cardboard is fed between the upper and lower clamping rollers. Since the thickness of the obtained product can vary in a wide range, the required shaft clamping is ensured by a uniform change in eccentricity by means of the sleeves, which ensures high-quality compression of the liner to the fluting of the micro-corrugated cardboard.

For researches, cardboard liners procurement and micro-corrugated cardboard of 190×190 mm were selected. The lamination was made at an average speed of 10 sheets per minute (20 samples for each individual variant). Ready-made models were kept for 24 hours until the glue was completely dry.

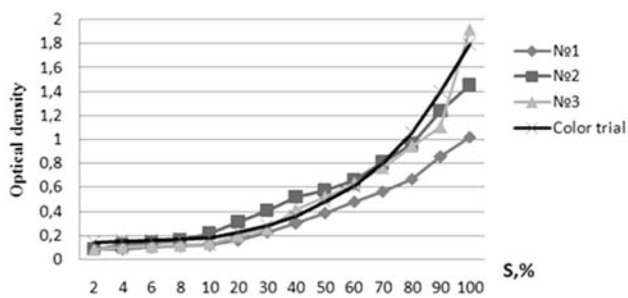
Definition efforts stratification and bonding strength of laminated micro-corrugated cardboard was carried out on tensile testing machines RMB-30-2M [10]. The research on the stability of laminated micro-corrugated cardboard to double bends was carried out using the device 'falser' type DFK. To study the change in the structure of micro-corrugated cardboard after the lamination process, the digital photo method was used (50–350 fold increase in image), which includes: OGME microscope, digital camera CCTV Manuel Camera, program for obtaining an image on the PC FLY 2000 TV monitor. To prevent the occurrence of an error in measurements and reliability of the results, 7–10 studies of each model were foreseen.

Results of researches

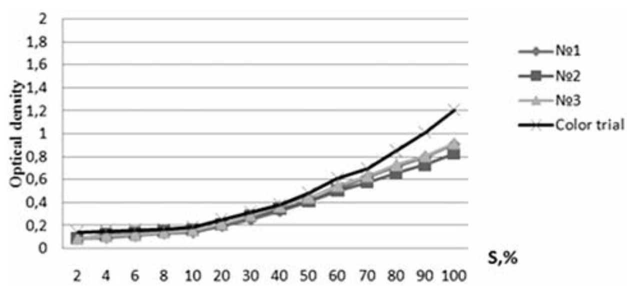
On the basis of statistical processing of the results of experimental researches graphical dependences of graduation transfer of color proof and offset imprints were constructed (fig. 2).



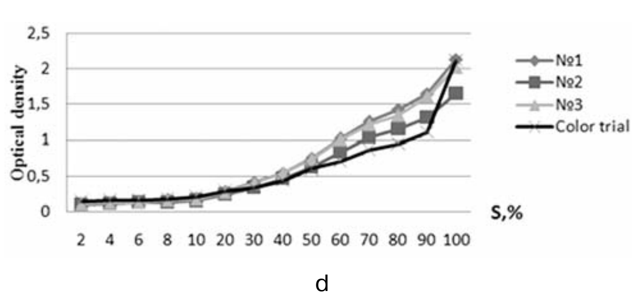
a



b



c



d

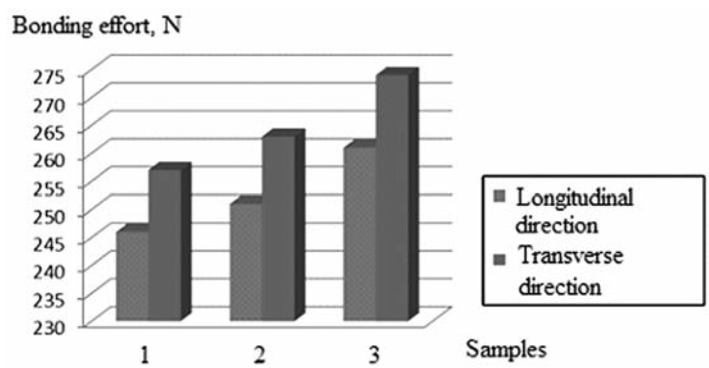
Fig. 2. Gradation transmission of the studied samples No. 1, No. 2, No. 3 with the raster linearity 175 lpi for: a — cyan, b — magenta, c — yellow, d — black ink

ISSN 2077-7264. Технологія і техніка друкарства. 2018. № 4(62)

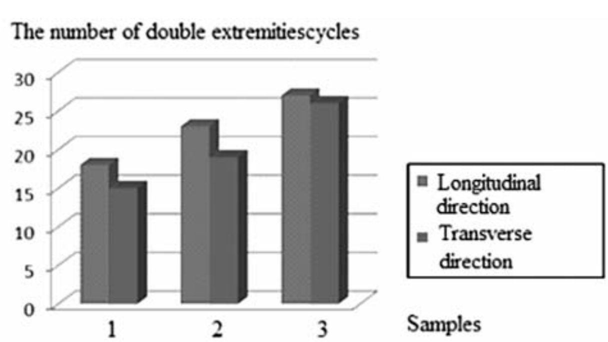
The analysis of the obtained graphic dependencies showed that the gradation of the blue ink of all studied samples (Fig. 2, a), more or less corresponds to the color proof in light areas, in the halftonnage, the optical density of the sample number 3 begins to increase and the trend continues in dark areas and decreases for the sample number 1, ranging from halftones to dark areas. The optical density is the closest to the color proof in model number 2.

As can be seen from Figure 2, b, a similar pattern is observed for purple ink: the gradation transmission in light areas is close to the color proof, in the half-tonal most approximation in the sample number 3, a slight increase in density in the sample number 2 and a decrease in the sample number 1, which continues and in dark areas. Instead, samples 2 and 3 in dark areas show roughly the same result.

Gradual transmission of the yellow ink (Fig. 2, c) shows a stable color transmission for all studied samples in light areas and halftones, and in dark areas density decreases in all samples No. 1, No. 2, No. 3.



a



b

Fig. 3. Diagram of stability of the studied samples: a — to bonding, b — to double bends

ISSN 2077-7264. Технологія і техніка друкарства. 2018. № 4(62)

Figure 2, d shows the dependence of the optical density for the black ink. As in the previous figures there is more or less stable transmission of gradation in light areas. In the halftone and dark areas, the optical density increases for samples number 1 and number 3. The sample number 2 is the closest to the color proof.

Thus, as it turned out as a result of the conducted research, the most stable result of the graduation transmission at the printing showed sample No. 2 (cardboard Arctika with a grammar of 215 g/m^2).

As a result of elaboration of the research results of the operational indicators of laminated micro-corrugated cardboard, histograms of bonding stability (Fig. 3, a) and double buckling (Fig. 3, b) of the studied samples were constructed.

As can be seen from Figure 3, a the difference between the strength properties in the machine and the transverse direction increases with the increase of the grammars of the studied samples. This phenomenon must be taken into account when designing packages, so the direction should be maintained perpendicular to the height of the package. Thus, the least breakthrough efforts are observed for the sample number 1 in the longitudinal direction of the fibers — 245 N. The greatest breakthrough effort was recorded in the sample number 3 in the transverse direction of the fibers — 272 N.

From the diagram shown in Figure 3, b it is evident that the greatest number of cycles of double extremities — 27 can withstand the sample number 3 in the longitudinal direction of the fibers, and the smallest number of double bends — 18 until the fragmentation stood sample No. 1 in the transverse direction of the fibers.

The analysis presented in fig. 4 microphotographs of laminated micro-corrugated cardboard before and after the tests indicates the presence of stratification in the places of adhesive compounds in all the studied samples number 1, number 2 and number 3, destruction occurs in the structure of the liner and fluting.

Conclusions

As a result of experimental researches, the following conclusions were obtained: in light areas all studied samples showed a result close to the color proof; in the halftones the most volatile transfer of gradations, as seen from graphic dependencies, in the ink magenta; in dark areas there are significant deviations from the color proof in all samples, the most stable gradation is transferred for the yellow ink in sample number 1. Nevertheless, after analyzing the obtained results, it can be said that the most closely approximated to the color proof was the sample number 2 (cardboard Arctika with a grammar of 215 g/m^2).

The investigation of the lamination of micro-corrugated cardboard and its quality indicate that particular attention should be paid to parameters such as the adhesive viscosity and the pressure at the lamination, which is determined by the distance between the adhesive and clamping rollers of the lamination device, which provide the contact of the fluting and liner in the process of manufacturing laminated micro-corrugated cardboard.

ISSN 2077-7264. Технологія і техніка друкарства. 2018. № 4(62)

Considering the results of the study of the technological and operational characteristics of laminated micro-corrugated cardboard, despite the high results of the sample number 3 (Arctika 250 g/m^2), we recommend for lamination the sample number 2 (Arctika 215 g/m^2), which forms with a micro-corrugated cardboard of the brand 311E with a fluting with a grammar of 140 g/m^2 strong adhesive bond, sufficient for operation of this packaging.

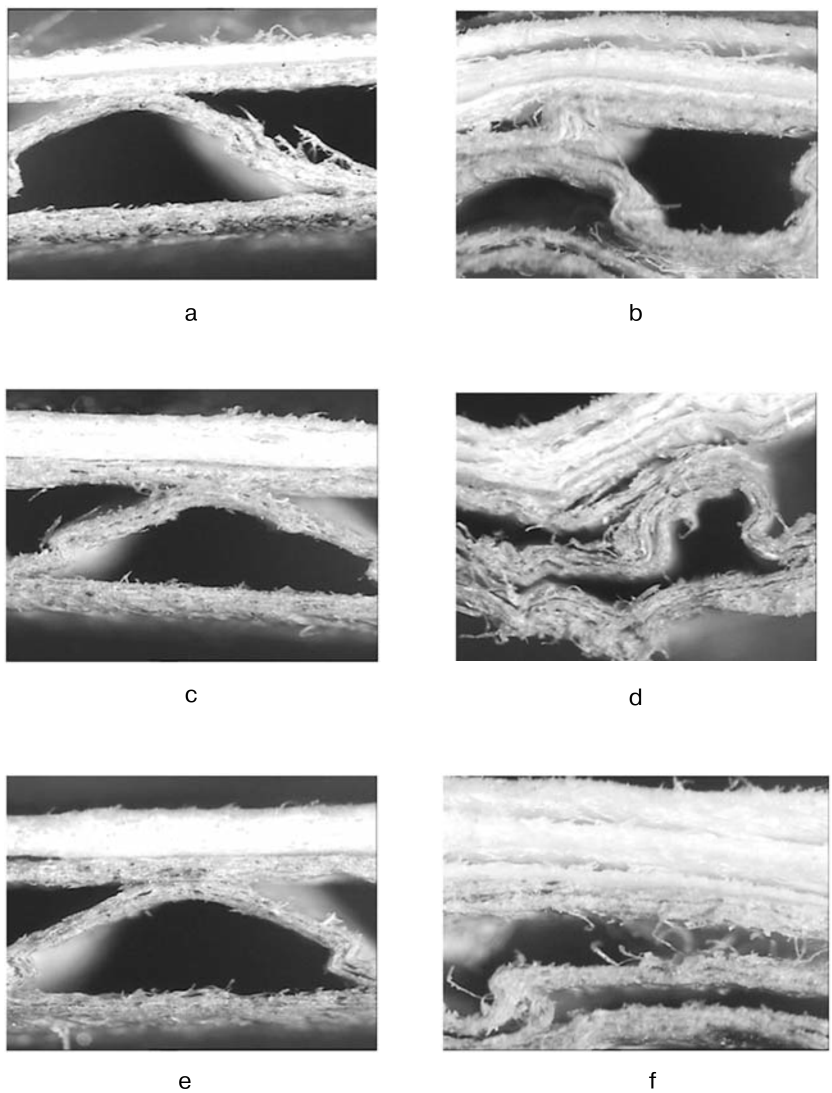


Fig. 4. Microphotographs of laminated micro-corrugated cardboard [× 100]: sample No. 1: a — before, b — after testing; sample No. 2: c — before, d — after testing; sample No. 3: e — before, f — after testing

ISSN 2077-7264. Технологія і техніка друкарства. 2018. № 4(62)

References

1. (2006). Tara s gofrokartona. Potrebnosti rynka SShA. *Journal of Tara i upakovka*, 2, 33 [in Russian].

2. Rehei, I. I. (2006). Kartonne pakuvannia. *Journal of Upakovka*, 5, 26–28 [in Ukrainian].

3. (2006). Gofrokarton i kartonnaya tara: nastoyashchee i budushchee. *Journal of Tara i upakovka*, 6, S. 28 [in Russian].

4. Nikolaeva, M. (2000). Upakovka iz gofrokartona: Pryamaya pechat' i kashirovanie. *Journal of Komp'yuPrint*, 30–34 [in Russian].

5. Havenko, S. F. & Bernatsek, V. V. (2013). Tekhnolohiia kashyruvannia mikrohofrokartonu. Lviv: UAD, 132 p. [in Ukrainian].

6. Bernatsek, V. V. (2006). Doslidzhennia protsesu kashyruvannia mikrohofrokartonu. *Journal of Tezy dop. nauk.-tekhn. konf. prof.-vykl. skladu, nauk. pratsivn. i aspir*. Lviv: UAD [in Ukrainian].

7. Bernatsek, V. V. (2010). Doslidzhennia systemy 'papir—klei—karton' v protsesi kashyruvannia. *Journal of Kvalilohiia knyhy*, 2, 64–66. Retrieved from http://nbuv.gov.ua/UJRN/Kk_2010_2_13 [in Ukrainian].

8. ISO 12647-2: 2004 / Amd 1: 2007 — *Managing the production of color-coded halftone images, trial and patch prints — Part 2: Offset sheet printing* [in English].

9. Havenko, S. F. & Bernatsek, V. V. & Rehei, I. I. *Kleiovyi aparat kashyruvalnoi mashyny* // Patent № 83440 Ukraine. Publish 10.07.2008 [in Ukrainian].

10. (1996). *Rozryvnaya mashina dlya bumagi RMB – 30 – 2M*, 10 p. [in Russian].

Список використаної літератури

1. Тара с гофрокартона. Потребности рынка США / [б/а] // Тара и упаковка. 2006. № 2. С. 33.

2. Регей І. І. Картонне пакування / Іван Іванович Регей // Упаковка. 2006. № 5. С. 26–28.

3. Гофрокартон и картонная тара: настоящее и будущее / [б/а] // Тара и упаковка. 2006. № 6. С. 28.

4. Николаева М. Упаковка из гофрокартона: Прямая печать и каширование // Марина Николаева // КомпьюПринт. 2000. сентябрь–октябрь. С. 30–34.

5. Гавенко С. Ф. Технологія каширування мікрогофрокартону: монографія / С. Ф. Гавенко, В. В. Бернацек. Л.: УАД, 2013. 132 с.

6. Бернацек В. В. Дослідження процесу каширування мікрогофрокартону / В. В. Бернацек // Тези доп. наук.-техн. конф. проф.-викл. складу, наук. працівн. і аспір.: [31 січня–3 лютого 2006 р.]. Львів: УАД, 2006. С. 43.

7. Бернацек В. В. Дослідження системи «папір—клей—картон» в процесі каширування / В. В. Бернацек // Кваліогія книги. 2010. № 2. С. 64–66. Режим доступу: http://nbuv.gov.ua/UJRN/Kk_2010_2_13.

8. ISO 12647-2: 2004 / Amd 1: 2007 — Управління процесами виробництва кольороподілених напівтонових зображень, пробних і накладних відбитків — Частина 2: Офсетний аркушевий друк.

9. Пат. № 83440 Україна. Клейовий апарат каширувальної машини / Гавенко С. Ф., Бернацек В. В., Регей І. І.; заявник і патентовласник Українська академія друкарства. Заявл. 26.02.2007; опубл. 10.07.2008, Бюл. № 13.

ISSN 2077-7264. Технологія і техніка друкарства. 2018. № 4(62)

10. Розрывная машина для бумаги РМБ – 30 – 2М / [б/а] // Паспорт. 1996. 10 с.

В роботі досліджено репродукційно-графічні показники лайнерів, задрукованих офсетним способом друку, розглянуто процес їх каширування до мікрогофрокартону з використанням клейового апарату нової конструкції з подальшим визначенням експлуатаційних показників пакувального матеріалу. В результаті досліджень було побудовано графічні залежності, які дозволяють оцінити якість відтворення кольорового зображення, віддрукованого офсетним способом друку та експлуатаційну стійкість кашированого мікрогофрокартону. Проведені експериментальні дослідження дозволили встановити залежність міцнісних характеристик кашированого мікрогофрокартону від технологічних параметрів процесу каширування.

Ключові слова: каширування; мікрогофрокартон; флютинг; лайнер; офсетний друк; відбиток.

В работе исследованы репродукционно-графические показатели лайнеров, запечатанных офсетным способом печати, рассмотрен процесс их каширования к микрогофрокартону с использованием клеевого аппарата новой конструкции с последующим определением эксплуатационных показателей упаковочного материала. В результате исследований были построены графические зависимости, позволяющие оценить качество воспроизведения цветного изображения, отпечатанного офсетным способом печати и эксплуатационную стойкость кашированного микрогофрокартона. Проведенные экспериментальные исследования позволили установить зависимость прочностных характеристик кашированного микрогофрокартона от технологических параметров процесса каширования.

Ключевые слова: каширование; микрогофрокартон; флютинг; лайнер; офсетная печать; оттиск.

Рецензент — О. В. Зоренко, канд. техн. наук, доцент, КПІ ім. Ігоря Сікорського

Надійшла до редакції 26.12.18