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BEATA KUŻDOWICZ, M.Sc / ORCID: 0000-0003-0681-6900
SEBASTIAN BANASIAK / ORCID: 0000-0002-8882-0024
ŁUKASIEWICZ INSTITUTE OF TECHNOLOGY, ŁÓDŹ

MODULAR SYSTEM OF PRODUCTION OF PACKAGING OF SRP TYPE – TESTING OF PACKAGING IN DIFFERENT CONDITIONS. PART 2. – LOWERED TEMPERATURE

MODUŁOWY SYSTEM PRODUKCJI OPAKOWAŃ TYPU SRP – BADANIA OPAKOWAŃ W RÓŻNYCH WARUNKACH. CZĘŚĆ 2 – NIŻSZA TEMPERATURA

ABSTRACT: In the present paper, the results of the research on the resistance of packaging to a static pressure were discussed. The test was carried out on Plaform® trays without a barrier coating and with the application of UKAPhob HR 530 barrier at a reduced temperature, assuming a wide range of humidity. In order to determine the effect of the increased cardboard humidity on the value of resistance to a static pressure, the tests were carried out after air-conditioning of the packaging in six different climatic conditions.
Key words: packaging boards, variants of research on the resistance to static pressure

STRESZCZENIE: W artykule zaprezentowano wyniki badań odporności opakowań na nacisk statyczny. Badanie przeprowadzono na tacach Plaform® bez powłoki barierowej i przy zastosowaniu bariery UKAPhob HR 530 w temperaturze normalnej, przyjmując przy tym szeroki zakres wilgotności. Dla określenia wpływu zwiększonej wilgotności tektury na wartość odporności na nacisk statyczny, badania wykonano po klimatyzowaniu opakowań w sześciu różnych warunkach klimatycznych.
Słowa kluczowe: tektury pudełkowe, warianty badań odporności na nacisk statyczny

INTRODUCTION

The contemporary packaging served not only a final wrapping of the product, or its protection during storage, transport or the protection of the natural environment from the harmful impacts of the discussed product. The application of packaging has become, for many years, subjected to transformations and to-day it has a more complicated status. It serves facilitation of production, transport and handling, sale and utilization itself of goods. It submits the information on the product and its application and consumer suitability and affects psychologically the consumer owing to its aesthetic values.

Producers and suppliers of packaging to the market employ the automated manufacturing process via the grouping and packaging systems, handlers and industrial robots, marking, labelling and film wrapping equipment and, finally, application of automated packaging and palletizing [1].

The present study was undertaken with the aim to conduct the tests of packaging, having the application in the market as "ready to be placed on the shelf" (SRP – Shelf Ready Packaging). It is a sort of grouped packaging which, apart from the transport function, play many other additional functions such as exposure or promotion. Their construction, properties and application

[1] Modular system of production of SRP type packaging – Testing of packaging, the tests conducted for PROTIM Ltd., Poznań

were discussed in the paper concerning the tests conducted at a normal temperature.

The planned cycle of the test of the packaging at a lowered temperature constitutes the second part of the project, aiming at the attempt to minimize the manufacturing costs of SRP packaging born by the producers as not to become a factor, significantly affecting the manufacturing costs.

Shelf Ready Packaging (SRP) is constructed in such a way that during the transport they are vertically stacked on the pallets. It is characterized by one of the basic resistance properties of the packaging employed in transport as well as during the storage and as a shop exposition. It is the resistance of the formed box to a static pressure and it is determined by Box Compression Test (BCT).

Testing of the resistance of the bow to a static pressure may be employed in evaluation of a given property of packaging in respect of its resistance to pressure or a degree of protecting its contents from the effect of crushing forces[2].

BCT test is a very good method for optimization of packing costs. We may therefore, obtain boxes with different resistance values from the same type of paper; it is determined by the technology of cardboard production. The corrugated cardboard is most frequently used in production of packaging.

The characteristic feature of the corrugated cardboard consists in its shape and level of wave; the height of the applied wave affects the properties of the corrugated cardboard. The higher is the wave, the better are the resistance parameters of the cardboard. A box that is made of such paperboard has a better rigidity but together with the increase in the height of the wave, the material consumption of the cardboard is also increased. For example, once commonly employed cardboard with a high "A" wave has good shock absorption properties and ensures relatively high stiffness of the box construction and resistance to a static pressure. Its further use is recommended but only in the cases of packing the products with a high sensitivity to mechanical damages, e.g. those made of glass. The cardboard

SHELF READY PACKAGING, APART FROM THE TRANSPORT FUNCTION, PLAY MANY OTHER ADDITIONAL FUNCTIONS SUCH AS EXPOSURE OR PROMOTION.

with a low "B" wave reveals a high resistance to crushing of the corrugated layer (FCT, Flat Crush Test) and should be employed e.g. in packaging of multi-piece products with a high weight e.g. tins with the preserved products or paints metal containers. We use, however, most frequently, the cardboard with "C" wave which has the intermediate values. In manufacture of double wall board or corrugated seven-layered board, the corrugated layers of different shapes are employed (e.g. B and C).

It is worthy to mention here production of paperboard with "G" microwave of 0.55 m height which has been employed in small unitary packages, obtaining a box with the walls of a high stiffness, dedicated e.g. for perfumes[3]. Also, the four-layered cardboard with "X" wave, being also called "Xitex" is the interesting solution. It consists of two flat external corrugated layers and two layers glued each other at the top sites of wave, with the wave higher than 0.8 mm than "C" wave. Such corrugated cardboard, as patented in Austria, is characterized by a high resistance to flat crushing and considerably lower

[2] PN-EN ISO 12048:2002 Packaging – Complete, filled transport packages – Compression and stacking tests using a compression tester

[3] Korzeniowski A., Commodity science of industrial products, Part III, Testing of the quality of products, Published by AE, Poznań 2006

material consumption as compared to double wall corrugated cardboard. The boxes made using the mentioned cardboard have good shock absorption properties and are more resistant to a static pressure that allows application of the cardboard with a lowered weight, with the preservation of the required resistance of the boxes[4].

The properties of multi-layered cardboards may be classified in few groups. They include strength, structural-dimensional and hygroscopic properties. The strength properties of the cardboard are greatly dependent on the length of fibres, their binding forces and the composition and type of fibrous raw materials, the employed adhesives, fillers and, also, external conditions during their use. The resistance properties are determined by testing of mechanical resistance of the cardboard; they include, inter alia: resistance to flat crushing (FCT, Flat Crush Test) and column crushing (ECT, Edge Crush Test), resistance to bursting bending and resistance to puncture (PET). In the case of determining the structural-dimensional properties, the conducted tests concern the composition and type of the raw material, thickness of the cardboard, type of wave and paper weight. The hygroscopic properties of cardboard consist in the easy absorption of humidity from the air and its return when the air is drier. In connection with the above fact, the content of moisture in the cardboard varies what affects the change in the parameters and, finally, the parameters of the produced packaging. Therefore, the cardboard packaging is tested in the standardized atmospheric conditions, most frequently at the relative humidity of 50±2% and temperature of 23±1°C. It is necessary to have the possibility of comparing the packaging made of different types of cardboards and with the different shapes.

THE AIM AND THE SCOPE OF THE STUDIES

In the research part of the study, the program of the tests of Plaform® trays made of double wall corrugated board without barrier coating and with the application of UKAPPhob HR 530 barrier, was implemented. General assumptions of the research work consisted in determination to what degree the conditions of temperature and humidity of conditioning of the cardboard affected its properties and how the characteristics of the cardboard was changing together with the change in the mentioned conditions.

The tests of the resistance of the packaging to the static pressure (BCT) by the method specified in standard PN-EN ISO 12048:2002E[5] were conducted at a lowered temperature. The tests were carried out for six conditions of air-conditioning.

PREPARATION OF THE SAMPLES

For the tests, the packages conditioned according to the criteria adopted for Stage 2 – Preparation of the samples at a lowered temperature, were used.

There were carried out 5 determinations for each Plaform® tray without barrier coating and with the application of UKAPPhob HR 530 barrier, successively for six climatic conditions.

THE RESULTS OF DETERMINATION

The tests of boxes' resistance to a static pressure were conducted without the contents, until the loss of rigidity of packaging, with the registration of the level of compressing force at this moment, expressed in kN. The test of the resistance to the pressure determines the resistance of the package to compression. It is expressed by the value of force, acting directly

TAB. 1. CONDITIONING BEFORE THE TESTS: 24 H, TEMPERATURE T 5°C, RELATIVE HUMIDITY RH 50%, BCT TEST WITHOUT BARRIER

No of sample	1	2	3	4	5	Mean
F [kN]	4,6	4,3	4,4	4,3	4,5	4,42

[4] http://ue.poznan.pl/data/upload/articles_download/22771/20140918/tekstura-falista.pdf

[5] PN-EN ISO 12048:2002 Packaging – Complete, filled transport packages – Compression and stacking tests using a compression tester

TAB. 2. BCT TEST WITH THE BARRIER

No of sample	1	2	3	4	5	Mean
F [kN]	4,4	4,6	4,4	4,4	4,5	4,46

TAB. 3. CONDITIONING BEFORE THE TESTS: 24 H, TEMPERATURE T 5°C, RELATIVE HUMIDITY RH 60%, BCT TEST WITHOUT BARRIER

No of sample	1	2	3	4	5	Mean
F [kN]	4,1	4,0	4,2	3,9	4,0	4,04

TAB. 4. BCT TEST WITH THE BARRIER

No of sample	1	2	3	4	5	Mean
F [kN]	4,1	4,1	4,2	4,5	4,1	4,20

TAB. 5. CONDITIONING BEFORE THE TESTS: 24 H, TEMPERATURE T 5°C, RELATIVE HUMIDITY RH 70%, BCT TEST WITHOUT BARRIER

No of sample	1	2	3	4	5	Mean
F [kN]	3,5	3,1	3,6	3,6	3,7	3,50

TAB. 6. BCT TEST WITH THE BARRIER

No of sample	1	2	3	4	5	Mean
F [kN]	3,6	3,5	3,5	3,5	3,5	3,52

TAB. 7. CONDITIONING BEFORE THE TESTS: 24 H, TEMPERATURE T 5°C, RELATIVE HUMIDITY RH 80%, BCT TEST WITHOUT THE BARRIER

No of sample	1	2	3	4	5	Mean
F [kN]	2,6	2,4	2,4	2,6	2,7	2,54

TAB. 8. BCT TEST WITH THE BARRIER

No of sample	1	2	3	4	5	Mean
F [kN]	2,7	2,7	2,7	2,7	2,8	2,72

TAB. 9. CONDITIONING BEFORE THE TESTS: 24 H, TEMPERATURE T 5°C, RELATIVE HUMIDITY RH 90%, BCT TEST WITHOUT THE BARRIER

No of sample	1	2	3	4	5	Mean
F [kN]	1,8	2,0	1,8	2,1	2,1	1,96

TAB. 10. BCT TEST WITH THE BARRIER

No of sample	1	2	3	4	5	Mean
F [kN]	1,9	2,1	2,1	1,8	1,8	1,94

TAB. 11. CONDITIONING BEFORE THE TESTS: 24 H, TEMPERATURE T 10°C, RELATIVE HUMIDITY RH 75%, BCT TEST WITHOUT THE BARRIER

No of sample	1	2	3	4	5	Mean
F [kN]	3,1	3,2	2,9	3,1	3,3	3,12

TAB. 12. BCT TEST WITH THE BARRIER

No of sample	1	2	3	4	5	Mean
F [kN]	3,3	3,2	3,2	3,3	3,1	3,23

on the box during its compression, causing its destruction or deformation.

The tests of the boxes' resistance to the pressure were carried out using Lorentzen& Wettre pres type CT 100 with mechanical drive. The mentioned press consists of two rigid flat plates. The upper plate is a mobile compressing plate. The maximum force of the pressure by the described equipment is equal to 100 kN. The rate of the press move during the test amounted to 5 mm/min.

THE RESULTS OF THE TESTS

The results of the conducted tests have been given in tables and in diagrams, representing the range of the values of the examined parameters.

The tables show the results of the test of resistance to a static pressure (BCT, compression test) at a lowered temperature, successively for six conditioning variants for packaging - Plaform® tray made of paperboard without the barrier coating and with the application of the mentioned barrier.

SUMMING UP

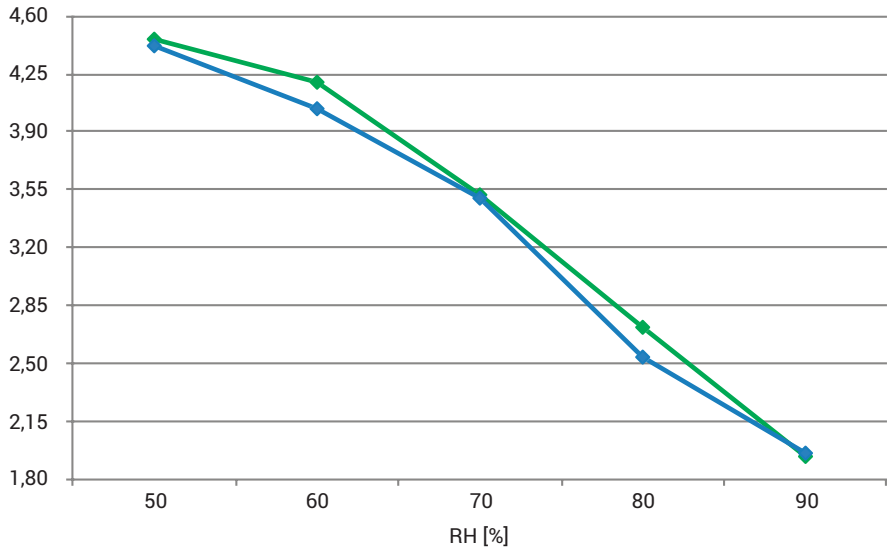
In Stage 2 – Testing of packaging at a lowered temperature, the determinations have been carried out and the results for Plaform® tray packaging made of paperboard without barrier coating and with the application of the mentioned barrier, successively for six climatic conditions have been submitted. The obtained values of determinations were given in the tables, showing the mean results for the selected climatic conditions.

BCT without barrier

The analysis of the results of the obtained values of resistance to a static pressure (BCT, box compression test) for Plaform® tray packaging indicates that the most favourable results were

TAB. 13. BCT TEST

	1	2	3	4	5	6
BCT without barrier	4,42	4,04	3,50	2,54	1,96	3,12
BCT with barrier	4,46	4,20	3,52	2,72	1,94	3,23
RH [%]	50	60	70	80	90	75
Temp. [°C]	5	5	5	5	5	10



PIC. 1. THE OBTAINED VALUES OF DETERMINATIONS WERE GIVEN IN LINEAR DIAGRAM, ILLUSTRATING THE RELATION OF BCT VALUE DEPENDING ON DIFFERENT CONDITIONING VARIANTS.

obtained for paperboard packaging with the application of barrier at the temperature of 5oC and relative humidity (RH) equal to 50%. Under the successively increased humidity conditions, BCT values were distinctly dropping for the paperboard without the barrier as well as with its application; the paperboard with the barrier revealed constantly better properties.

The obtained values of determinations were given in linear diagram, illustrating the relation of BCT value depending on different conditioning variants.

The analysis of the results of Stage 2 allows the conclusion that the conditions of packaging conditioning at various values of relative humidity affected significantly the results of determinations of the performed tests, both for packaging and paperboards without the coating and with its application.

When comparing the results for the selected conditioning variants and their mean values, certain regularities were recorded. The results of BCT determination for Plaform® tray packaging are most favourable for the conditions T=5oC and RH=50% for the packaging without coating as well as in the case of its application. Throughout the whole cycle of the test with the successive use of all conditioning variants, the more favourable results were decidedly obtained for the packaging with the barrier.

The above fact indicates that the circumstances of conditioning the paperboard have the effect on the results of the conducted tests. Higher values of relative humidity have a negative impact on BCT test, decreasing the resistance properties of paperboard. When analysing the obtained results of the performed determinations, we may observe that the highest differences were recorded in the comparison of the results obtained for the lowest and the highest conditions of relative humidity. <<

LITERATURE

1. http://ue.poznan.pl/data/upload/articles_download/22771/20140918/tektura-falista.pdf
2. Korzeniowski A., Commodity science of industrial products, Part III, Testing of the quality of products, Published by AE, Poznań, 2006
3. Modular system of production of SRP-type packaging – testing of packaging, the tests conducted for PROTIM Ltd., Poznań, 2019
4. PN-EN ISO 12048:2002 Packaging – Complete, filled transport packages – Compression and stacking tests using a compression tester