UDC 655.3.066.53+655.3.066

THE RESEARCH OF INFLUENCE OF PHYSICAL AND MECHANICAL PROPERTIES OF OIL AROMA VARNISHES ON PRINTING PRODUCTS QUALITY IN WEB OFFSET

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The influence of aroma varnish surface tension on the quality of varnishing was under consideration in the article. Factors that impact the process of varnish wetting of the printing plate and prints, their roughness and topography of the surface in particular, are indicated. Based on a simulation model of the process of selective varnishing of paper prints, the need of adding of hard artificial resin balls with a diameter bigger than the diameter of the microcapsules into the aroma varnish composition was proved. This prevents their premature destruction in a printing machine, providing the intensity of aroma areas on the prints.

Keywords: *aroma varnish, offset web printing, surface tension, roughness, advertising*

Problem statement. Modern printing products with the use of aromatization reveal a great opportunity for modern producers: allow a potential buyer to select this advertising appeal, among other goods; increase the contact time with the advertised item and thus enable to become more familiar with it. Also aromatized objects form a positive attitude to the advertised object and the buyer has the desire to buy it that increases the effectiveness of advertising. Aromatization of advertisements can be achieved by using varnishes, inks, glues containing some kind of aromatized components.

Analysis of previous researches. Analysis of methods of aroma prints formation by different printing technologies, made by predecessors, showed that many factors influence the aroma images' quality, such as: the method of coating, the chemical structure of varnish, the way of fixing it on the surface of the print and others. Mechanism of aroma varnishes' film creating is a complex process that runs several stages. But most researchers distinguished two of them – physical process of film formation (due absorption) and chemical (through the chemical reaction of oxidative polymerization).

The research of wetting phenomena, absorption, chemical interaction between printing inks, varnishes and printing material (paper, cardboard, foil) was conducted by many researchers — Velichko O., Klimova O., Kozarovitskyj L., Kulak M., Piotuh I., Popryaduhin P., Rebinder R., Shybanov V., Khokhlova R. and others. Klaus Hanke and Andrea Heyneman describe in their works the surface decoration of offset prints by dispersion of varnishes and printing inks [1, 2].

However, it should be noted, that carried out experimental studies of structural and mechanical properties of printing varnishes were related to finishing processes in

sheet offset printing, mainly by usual dispersion, oil and UV varnishes. The physical and chemical phenomena in the interaction of UV aroma varnishes with cardboard and paper in sheet offset printing are investigated only in Kotmalova's O. works [3]. However, there is no study of the impact of topography and paper surface structure on aroma prints' quality formed by oil aroma varnish in web offset printing, which is now popular for advertising products.

The aim of research. Therefore, the aim of research was to identify the impact of physical, chemical and physical mechanical properties of printing (oil) aroma varnishes on the quality of finishing printed products.

Experiment equipment and method. The objects of research were selected prints on coated papers – mat with wood pulp impurities, double coated smooth surface NovaPres Silk (Stora Enso group) and single layer easily coated glossy UPM ULTRA H (UMP Kymmene company). Prints varnishing was carried out in web offset printing machines KBA C215 by using it ink system with plasma IR drying SIRIUS.

Printing oil aroma varnish Aromit Fragrance - Varnishes with aroma Folco Scent of 23223 Lucia Edt («Folmann», Germany) was used: 0,2Gew% Folmaldehyl% (CAS 50-00-0); 0,1-1 Gew% Benzylsalicylat (CAS 11-58-1) - №1 and varnish Aromit Nature Secret with micro capsulated aroma Folco Scent of 30,468 («Folmann», Germany): composition 1,0-5,0% Gew%: 1- (1,2,3,4,5,6,7,8-Octahydro-2,3,8,8-tetramethyl-2) - №2. It contained up to 10% micro capsulated aroma in varnish composition.

The dynamic stickiness of varnish is 758 mPas at the temperature of 21-23 °C, the viscosity of varnish is1097 kg/m^3, the kinematic stickiness is 690 •10-6 m^2/s. The eventual is 50–60%, the amount of deposited aroma varnish is 1,5 – 1,8 g/m. The task of selective varnishing was resolved by application of varnish coating on the surface of the printed images through the division of an ink box into several parts of the web offset machine. The surface of the printed images was simultaneously coated by different amounts of varnishes with different micro capsulated aroma.

Research methodology of physical chemical and mechanical properties of aroma varnishes. Goniometer PGX Fibro Systems AB for measurements of statistical and dynamic surface properties (surface tension) was used. The goniometer registers the absorption of drop solution on the material surface in a time, and then analyzes in detail the wetting angle and compares with a drop of distilled water up to 0,5 μl. The camera takes up to 30 shootings during the first second of the drop contact with the base until it disappears in the test material. The measurements comply with ISO.

Results of the research. The quality of aroma varnish prints coating depends on the composition of aroma varnish, its surface tension and corrected balance of system «varnish-wetting solution» [4–6]. The model of a coated paper moistening by aroma varnish (Fig. 1) shows time changes of volume and height of varnish drop. With time increasing from 3.99 s to 5.91 s drop volume varies from 2.96 to 2.97 at a constant height of 0.96.

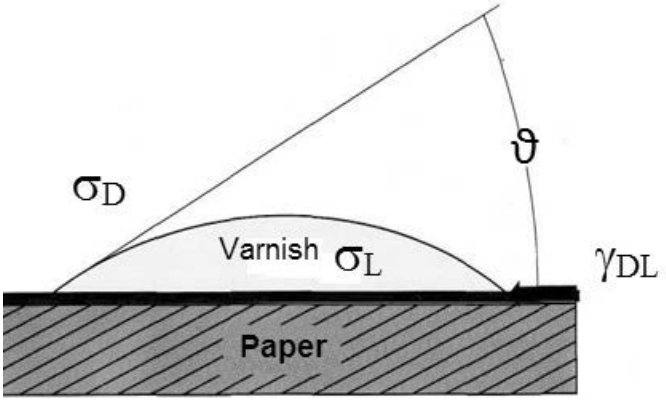

Fig. 1. The model of coated paper moistening by aroma varnish, where:
ϑ – moistening angle; σ_L – surface tension of aroma varnish; σ_D – surface tension of ink; γ_{DL} – surface tension on the border paint/aroma varnish; ϑ=0 – complete ink and paper moistening by aroma varnish; ϑ> 0 – insufficient moistening; ϑ=180 ° – no surface moistening by aroma varnish (in theory completely adhesion absence)

It was defined that the dynamic moistening angle of the printing plate surface and its surface tension for aroma varnishing (Fig. 1) as prints' aromatization in web machine KBA-215 is due to the printing apparatus.

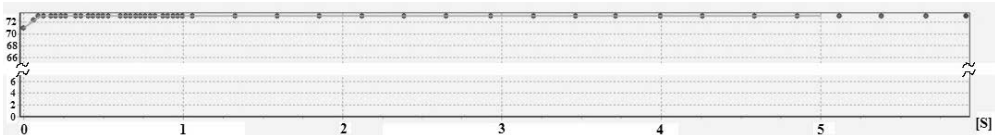

Fig. 2. Determination of the dynamic moistening angle of the printing plate surface

The data in Fig. 2 show that the forms average roughness is Ra = 0,48 μm. Moistening angle is stable. Initial angle increases from 71° to 73° within 0,2 s. Surface tension is 42 mN/m. 3D surfaces of printing plate, made on the device AniCam, are shown on Fig. 3.

Analysis of the results showed that the printing plate surface roughness is Ra = 0,50 μm, Rz = 2,91 μm, Rt = 3,96 μm (max. standard deviation 0,34μm). This means: more roughness of surface shape leads to better transfer of varnish onto the paper.

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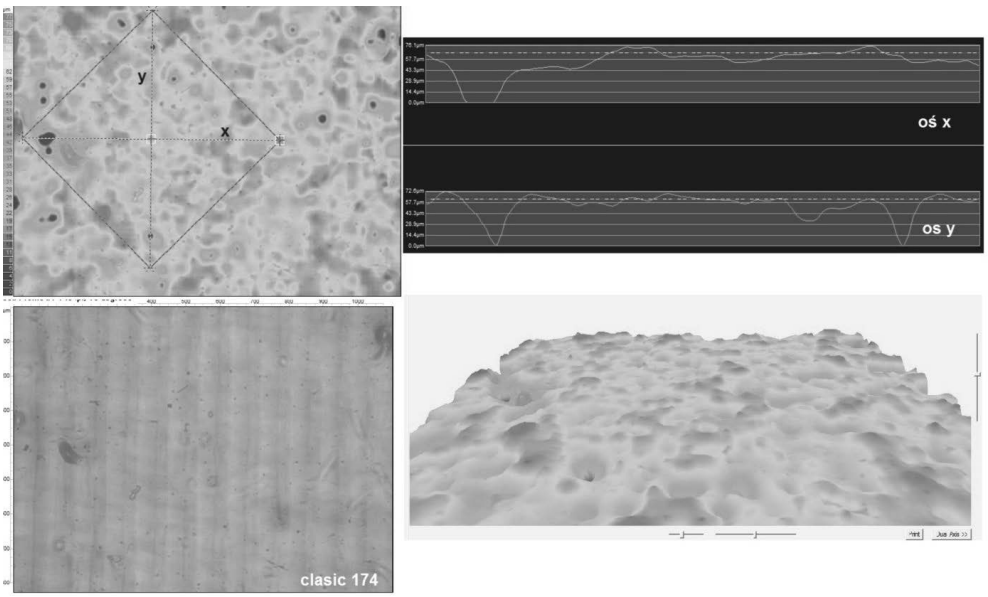

Fig. 3. Profile of printing forms' structures and its 3D image

Figure 4 shows the measurement of dynamic moistening angle of paper surface NovaPres Silk (free surface energy) in a time of 5s after applying a drop of distilled water of 0,3 µl. The angle was stable. Moistening angle decreased from 76° to the 74° during 1s and during 5s – to 73°. Research of change of static moistening angle during 10s showed similar results. Surface tension is 38 mN/m.

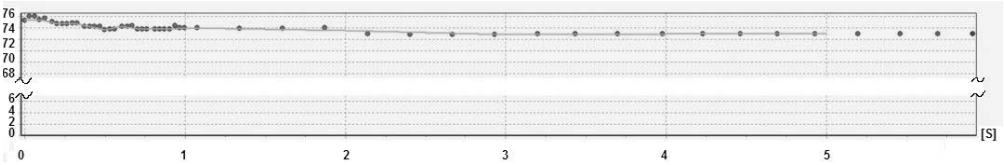

Fig. 4. Measurements of dynamic moistening angle of surface paper NovaPres Silk

A similar pattern is typical for determining the moistening angle of paper UPM Ultra. During 5s moistening angle varies from 76° to 73°. Surface tension is 34 mN/m.

Therefore, global manufacturers of aroma varnish recommend to use no more than 5-10% of a aroma in a composition for selective varnishing of image fragments on advertising, as increasing of aroma quantity leads to the changes in surface tension [5].

Increasing of surface tension of oil aroma varnish also causes the deterioration process of wetting during its application onto prints in web offset printing. Paper UPM Ultra has significant macro and micro surface inequality and roughness parameter is Ra = 1,36, that's why varnish layer deeps into the structure and leads to over-varnish (percentage of varnish conversion to paper is 18.21%). A slightly different picture is observed for paper surface Nova Pres Silk with double coated

layer and wood pulp. Thus, the roughness parameters Ra decreased to 0.40 m, with peaks area Speak increased to 856 um^2 and cavity area S_{cv} decreased to 358 um^2. It shows that varnish layer smoothes micro irregularities of paper surface.

Analysis of experimental researchers showed that slightly low surface tension of paper UPM Ultra provides less thickness of aroma coating because of the deeper penetration into the paper structure compared with paper NovaPres Silk, which in its turn makes it difficult to do aroma coating by «rub and smell» method.

It is important to define quantify indicators of varnish transfer according to GOST 2456-80 to determine the quality of aroma coating and forecast effective intensive use. It was carried out the value coefficient of varnish transfer for study papers as a result of measuring optical densities of prints.

The coefficient of varnish transfer for paper Nova Pres Silk is 2.35 (12.7%), and for paper UPM Ultra – 2,55 (17,6%), respectively. As a result, it was confirmed, that paper surface topography, its homogeneity, macro and micro structure, roughness parameters of paper, the number of coated layers affect the amount of varnish, which is transferred from form to paper under identical printing conditions (velocity and pressure). Therefore the coefficient of varnish transfer is much lower (12.7%) for the paper with two coated layers, in addition also mat, and accordingly lower roughness coefficient.

Correct varnish transfer during contact between forming and printing cylinder requires some pressure between them, in order to ensure an increase of adhesion between the varnish and varnishing basis, reduce cohesive forces that occur in the varnish surface layers. Thanks to this in the moment of contact the varnish starts to flake, otherwise – the layer of varnish can remain on the form. Increased strength of clamping cylinders leads to single destruction (damage) of melamine membranes of micro capsules and premature release of fragrance [4]. Distance retainers (artificial resin balls which dimensions are slightly bigger than aroma capsules) in the varnish have the significant impact on the printing process.

The model of application process of aroma varnish in web offset printing is shown in Fig. 5. To prevent the destruction of the micro capsules during printing, the so-called «gap constraints» are applied, i.e. round, hard artificial resin balls, which diameter is bigger than the diameter of micro capsules.

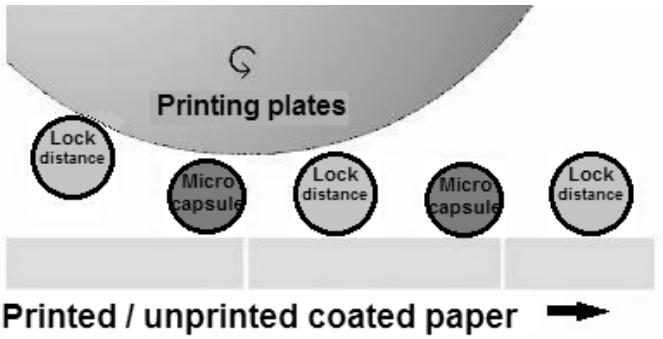

Fig. 5. The model of application process of aroma varnish to the prints

Balls protect the microcapsules and reduce the danger of premature failure at the moment of high pressure between printing material and printing plates. Under the recommendations of researchers and manufacturers of aroma products share restrictor gap in the finished print varnish composition should be from 2 to 7%. With the correct varnishing regimes and appropriate choice of chemical varnish composition, its binder evenly distributes on the surface layer of paper, moisturizes it, forms a film coating to which the microcapsules with aroma substances are deposited.

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ДОСЛІДЖЕННЯ ВПЛИВУ ФІЗИКО-МЕХАНІЧНИХ ВЛАСТИВОСТЕЙ МАСЛЯНИХ АРОМАТИЗОВАНИХ ЛАКІВ НА ЯКІСТЬ ПРОДУКЦІЇ ОФСЕТНОГО РУЛОННОГО ДРУКУ

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В статті досліджується вплив поверхневого натягу аромолаків на якість процесу лакування. Показано фактори впливу на процес змочування лаком друкарської форми та відбитків, а саме їх шорсткості та топографії поверхні. На основі імітаційної моделі процесу вибіркового лакування паперових відбитків підтверджується необхідність введення до складу аромолаку твердих кульок штучної смоли, діаметр яких більший за діаметр мікрокапсул, які перешкоджають їх передчасному руйнуванню в друкарській машині, забезпечуючи інтенсивність аромозон на відбитках.

Ключові слова: *аромолак, офсетний рулонний друк, поверхневий натяг, шорсткість, реклама*

Стаття надійшла до редакції 02.09.2015.
Received 02.09.2015.