INFLUENCE OF THE RENEWABLE RAW MATERIAL IN OFFSET INKS ON THE CHARACTERISTICS OF THE RECYCLED FIBERS

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ABSTRACT

For intervention into the composition of the conventional offset inks based on mineral oil, the needs for decreasing the emission of volatile organic compound level and decreasing the non renewable raw materials of the petroleum derivates are responsible from the ecological aspect. The influence of the renewable raw material in offset ink on the characteristics of the recycled fibers is presented in the article. The influence of the composition of ink and the printing substrate on handsheet brightness, the distribution of the number, size and the particle surface of the ink on handsheet from the different phases of the recycling process has been discussed.

1.INTRODUCTION

Offset inks, no matter if they are intended for the sheet offset or the web offset (coldest, heatset), contain colorant, coloring agent, vehicle and additives.

Vehicle is the variable pattern of ink. It consists of one or more hard resins obtained from the petroleum or derived from pine tree rosin [1]. The hard resin is solubized into two kinds of solvens: vegetable oils (linseed oil, soya oil)-renewable raw matherials and mineral oil, petroleum distillates, come from specific distillation cuts of fuel - the non renewable raw materials [2].

Except that the vegetable oil is not used only in its natural form,: it can be used as renewed polymerized form – pre-polymerized form alkyd resins. Alkyd resins usually contains up to 80% of vegetative oil [3].

For the intervention into the composition of the conventional offset inks based on mineral oil, the need for decreasing the emission level of volatile organic compound is responsible from the ecological point of view. The health and security risk on the working place as well as the possibility of VOC compounds to act as reactants in photochemical reactions in free atmosphere are known. From the ecological aspect, except the mentioned, it is important to decrease the ratio of the non renewable raw materials petroleum derivates in offset inks [4].

For the usage of vegetable natural oils in inks, the following values are interesting: average molecule weight, viscosity and low speed of absorption into paper coating. Different from vegetable oils, the mineral oils have less average molecule weight, lower viscosity and fast penetration into the paper coating.

Just because of the verified fact that the natural vegetable oils are absorbed into the substrate at lower rate than mineral oils, as direct consequence on the printing press, the ink exhibits a slower setting time. Unsatisfactory litho properties are also possible [5].

A significant progres at the end of the last century in sheetfed offset inks formulation is new kind of solvent- the vegetable esters. The tall oil fatty acid ester comes from wood industry. Vegetable esters results from the reaction between the fatty acids of soybean oil, rapeseed oil, coconut oil and alcohols methanol and isobutanol. These esters are similar to the mineral oil molecules in the length of hydrocarbon segment, average molecule weight and viscosity.

Because as the mentioned properties are much nearer to the mineral oils than to triglycerides, similar properties in printing inks can also be expected. The volatility of the vegetable esters is similar to the volatility of the mineral oils. Their next essential characteristic is compatibility in hard resin. Vegetable esters without the aromatic parts in the molecule show greater strength of resin dissolution in relation to the mineral oils [6].

In offset inks, the hydrocarbon resins coumarine – indene and modified colophony resins are used.

Hydrocarbon resins are the result of polymerization of hydrocarbon monomers into the polymers of low molecular mass. The obtained polymers are thermal plastic, of good solubility but the restricted bearability with the vegetable oils and alkyd resin [7,8].

In order that the colophony resin could form high elastic systems without the phenol formaldehyde modification, it is necessary to structure it. The development of highly structured resins was a large contributor to success in developing inks in relation to the technological and ecological demands.

The investigation results of the renewable raw material influence in offset inks in combination with the printing substrates of different compositions on the characteristics of the recycled fibers have been presented in this work. Some optical properties, the distribution of ink particles number and the particles sizes area of ink on the handsheet from different phases of the deinking flotation process have been discussed.

2. EXPERIMENTAL

For the preparation of the print the conventional and the model offset ink was used. The model offset ink consists of pigment, alkyd resin, structured colophony resin, vegetable ester, mineral oil and additives. Fine art paper matt and glossy and the non coated paper were used for printing.

Samples for recycling were made on Heidelberg printing machine. The test for was designed by using the standard ISO and ECI patterns and it was created in Adobe Photoshop application. The whole representing the ECI measuring segment consists of 210 patches of different combinations of ink values of subtractive analysis, generated by vector graphics in steps of 50%. The test form contains classic printing elements for controlling the reproduction quality, graduated CMYK wedges and standard achromatic and chromatic illustrations.

In the recycling process of the samples, alkaline chemical deinking method was used. In the process of the chemical deinking, the following chemical were used: 2% sodium silicate, 1% sodium hydroxide, 1 % hydrogen peroxide, 0,3% DTPA and 0,3% non-ionic surfactant. Percentages are on dry weight fibres.

Handsheets were produced before and after flotation in accordance to TAPPI standard T 205. The brightness of the handsheet was measured according to ISO standard method.

Optical parameters for sample series description were performed by X-Rite spectrophotometer with the support of ColorShop program. The measuring results were processed by means of Data Analysis program and technical Graphic Origin Professional.

Residual ink spot size, ink spot number, and ink areas were assessed with image analysis software Spec*Scan, Apogee Systems Dirt particle analysis procedure included: image acquisition, digitalization, image enhancement, segmentation, binary image processing, measurement of dirts and data output.

3. RESULTS AND DISCUSION

In order to present the total range of information in regard to the different ink formulation, including the tone, saturation and brightness, which are possible to be reproduced on the given medium, the two-dimensional and the three-dimensional gamuts of prints are presented [figure 1].

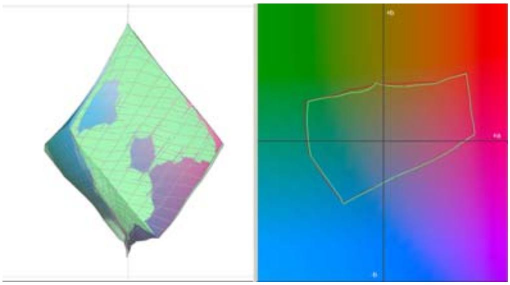


Figure 1. Comparable two-dimensional and three-dimensional gamut presentation of prints with the conventional offset ink and the ink based on renewable raw material

As it is visible from the result presentation, there are no great differences visible between the gamut of prints made with ink of different formulation in the area of blue, magenta and red. However, somewhat greater gamut closes the print made with the conventional offset ink in the area of orange, over yellow and even in cyan area.

This information is important in relation to the print quality. Because s the characteristics of fibers are the main goal of this research, the ISO brightness of handsheet from different process phases of print recycling in relation to the composition of ink and the printing substrate is presented in figure 2

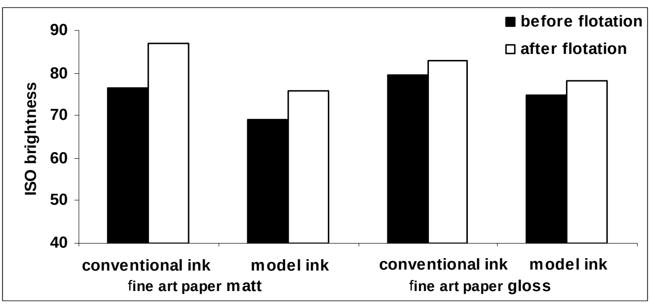
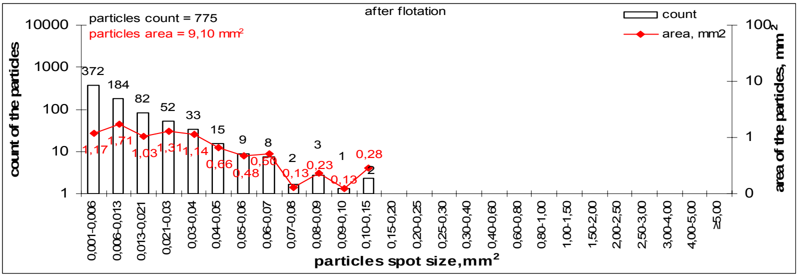


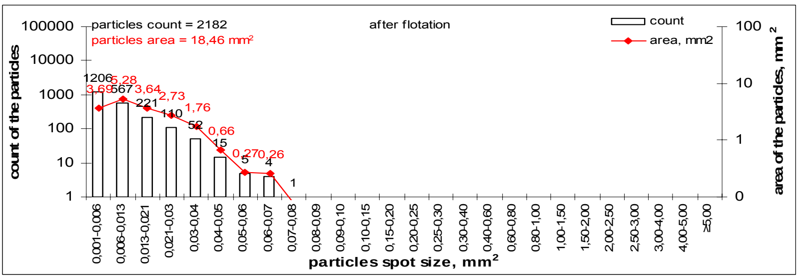
Figure 2. The influence of the chemical composition of the ink and the printing substrate on handsheet brightness

Handsheet made from fibers after the recycling of prints made with the ink based on renewable raw material have smaller brightness in relation to the conventional offset ink on both used printing substrates. Except that, in processing the prints made on fine art matt paper somewhat greater values of brightness are gained (for conventional ink 11,0, for ink based on renewable raw material 6,5,) in relation to the fine art glossy paper (for conventional ink 3,5, for ink based on raw material 3,0). These values are the indicators of successfulness of the deinking flotation process itself.

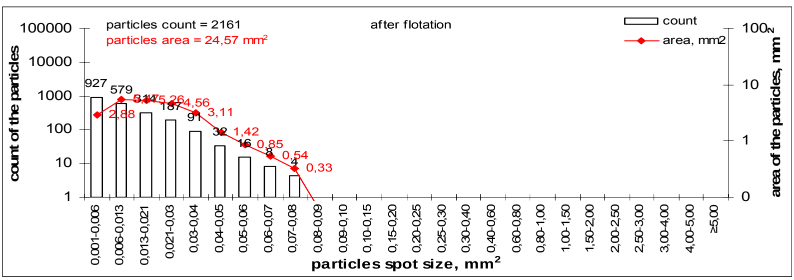
For better control and explanation of the influence of the used graphic materials on the deinking flotation process and the characteristics of the recycled fibers the method of image analysis was used, and the results are presented as follows:



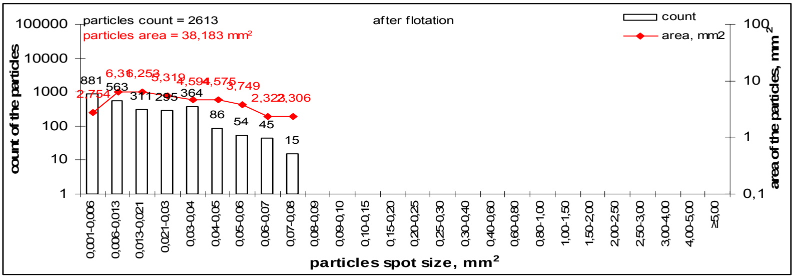
a) Print with conventional ink, fine art matt paper



b) Print of ink based on renewable raw material, fine art matt paper



c) Print with conventional ink, fine art glossy paper



d) Print of ink based on renewable raw material, fine art glossy paper

Figure 3. Distribution of particle sizes and their surface on handsheets made of fibers after flotation

The results obtained by image analysis confirm and explain the previously presented results of handsheet brightness. The smallest number of ink particles on handsheet made from the fibers after recycling was obtained by deinking flotation of prints made with the conventional ink on fine art matt paper (775 particles). The majority of ink particles do not contribute to the optical homogeneity of handsheet but they increase their greyness. By using the ink based on renewable raw material the number of particles on handsheet after flotation is increased 64,5%. In this case, the relation of ink particles smaller than 0,04 mm^2 increases in relation to the visible particles. By processing the conventional ink in relation to different printing substrates (fine art glossy paper) the number of ink particles increases 11,5 %. By processing the ink based on renewable raw material, with regard to the printing substrate, the number of ink particles increases 16,5 % when fine art glossy paper was used.

The effectiveness of deinking flotation of prints made on fine art matt paper with the conventional ink is 78,0%, and with the ink based on renewable raw material, it is 65,1 % in the framework of the described experimental conditions. When the fine art glossy paper is used in printing as well as the conventional ink, the effectiveness of deinking flotation is 71,1%, and when the ink based on renewable raw material is used, it is then 42,2 %.

In figure 4. The offset prints made on different printing substrates are presented after defibering and disintegration

Figure 4. Offset prints made on different printing substrates after defiberation and disintegration a) fine art matt paper b) fine art glossy paper

The problem of bad deinking effectiveness of offset prints on the coated paper, specially on glossy paper is explained by the fact that the ink detaches with the pigment coating during pulping, as it is visible in figure 4. The behaviour and the hydrodynamic supposition of the flotation process depend on the specific characteristics of the agglomerate coating/ink, which results in the particle number and the surface the particles occupy on handsheet from different process phases, in handsheet brightness and in other words the effectiveness of the process itself. O

4. CONCLUSION

Based on the research results, it can be concluded that the offset ink based on the renewable raw materials with greater ecological suitableness in comparison with the conventional ink does not differ much in regard to the gamut of prints.

On handsheet obtained from the fibers after recycling of prints by the method of alkaline chemical deinking flotation there are particles with the class mostly up to 0,04mm^2 which decrease the handsheet brightness handsheet but do not influence at its optical homogeneity. Greater handsheet brightness is achieved by print recycling made with the conventional ink in relation to the prints made with the ink based on renewable raw materials. The influence of the printing substrate composition on effectiveness of deinking flotation is visible. Somewhat greater handsheet brightness is the result of print recycling made fine art matt paper in comparison to the fine art glossy paper. Greater number of particles greater than 0.04mm^2 is on handsheet obtained from fibers after disintegration and flotation of prints made on fine art glossy paper.

5. REFERENCES

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