SIZE OF THE INK PARTICLES AFTER PULPING IN THE FUNCTION OF PRINT AGEING

VELIČINA ČESTICA BOJILA NAKON PULPINGA U FUNKCIJI STARENJA OTISAKA

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Abstract

The research results of the influence of print ageing on the size and number of ink particles on handsheet after disintegration of prints and their influence on the recycling effectiveness are presented in this work. The influence of the printing substrate and the composition of ink with regard to the renewable raw material proportion and detaching of the ink particles from the cellulose fibers are discussed.

The research results confirm weaker recycling effectiveness of the aged prints, especially with inks with greater proportion of the renewable raw materials in relation to the non aged prints which can be explained by oxidative processes and chemical interaction between ink and the substrate.

Key words:

offset prints, conventional inks, renewable raw materials, recycling, image analysis

Sažetak

U radu se prikazuju rezultati istraživanja utjecaja starenja otisaka na veličinu i broj čestica bojila na handsheetu poslije dezintegracije otisaka, te njihov utjecaj na efikasnost reciklacije. Diskutira se utjecaj vrste tiskovne podloge te sastav bojila obzirom na udjel sirovina obnovljivog porijekla kao i na odvajanje čestica bojila s celuloznih vlakanaca .

Rezultati istraživanja potvrđuju slabiju efikasnost reciklacije starenih otisaka, posebno s bojama s većim udjelom sirovina obnovljivog porijekla u odnosu na nestarene, što se pojašnjava oksidativnim procesima i kemijskom interakcijom između boje i podloge.

Ključne riječi:

ofsetni otisci, konvencionalne boje, obnovljive sirovine, reciklacija, slikovna analiza

1 Introduction

Each printing technique has different demands in the context of ink characteristics, The kind of ink used in printing determines the effectiveness of these operations.

The kind of printing technique and types of ink determines the effectiveness of the deinking operation too [1, 2]. Success in removing dispersed ink is determined by ink surface chemistry, particle size and particle geometry.

The printing ink drying process has a decisive influence on deinkability of the prints Coldset inks in web offset printing are formulated for absorptive drying, the mineral oil absorbs in the paper and the resins and the pigments are bound on the paper surface [3]. These prints type are easily deinkable.

Web offset heatset inks drying by evaporation is also easily deinkable [4]. The vegetable oils or alkyd resins are present in these inks in small amounts. Conventional offset inks beside absorbing mineral oils, contain also oxidative drying components fatty alkyd resins or linseed oil [5]. The components absorb oxygen, which causes cross-link polymerization and insoluble molecules with a high mechanical strength. The pigments attach to the printing substrate and use the oxidized parts of the binder. Oxidation drying inks are difficult to deink.

Conventional flexographic is poorly deinkable, due to the small ink particle size and hydrophilic surface chemistry of the ink [6].

Drying by high energy radiation, inks cannot easily detach from fiber. Beside the drying mechanism, binder and solvent characteristics influence deinkability too [3]. The problem is that the binders can react with the chemicals used in deinking process.

Nonimpact prints after pulping provide larger ink particles than prints obtained with conventional printing techniques [7]. These particles result in insufficient removal during flotation. The ink dissolves in disintegration process of ink-jet printed paper and flotation deinking cannot remove it.

The research results of the influence of the print ageing process before recycling on the handsheet particle size after pulping and disintegration are presented in this work. The influence of the printing substrate and the ink composition on the size and number of ink particles on handsheet after disintegration and their influence on the recycling process effectiveness as well as the characteristics of the recycled fibers are discussed.

2 Experimental

Colour prints made on the conventional offset sheet fed printing machine Heidelberg are used in the researches. Test form has been designed by using the standard ISO and ECI patterns. It has been created in Adobe Photoshop application. The part presenting the ECI measuring segment consists of 210 patches of different combinations of colour values of the subtractive analysis, generated by the vector graphics in steps of 5%.

One series of prints was produced with the conventional offset ink based on mineral oil and the other with the ink ecologically more friendly with greater amount of renewable raw materials. In the experimental part, different printing substrates were used. It was printed on fine art paper matt and glossy and on the coated and uncoated offset paper

After the printing, the prints were differently treated before the further analyses. Based on that, they were divided in two series: non aged prints and accelerated aged prints. For accelerated ageing, the climate chamber was used with the following conditions: temperature 80^0C, humidity 65%, without radiation.

In the recycling process alkali chemical deinking was used. The conditions in the recycling process were the same as in the cited work [8]. The handsheets were made using a laboratory sheet former, according to standard TAPPI method T 205. For measuring the three-stimulus values X-Rite DTP 41 spectrophotometer with the illumination geometry of $45^0/0^0$ was used.

Residual ink particles size (area) and number were assessed with image analysis-based software systems: Spec*Scan (Apogee System).

3 Result and discussion

In table 1 the results of the image analysis of handsheet after disintegration of prints made on fine art glossy paper with the conventional offset ink (sample 1) are presented. In another case the prints were made with

ink with greater amount of renewable raw materials (sample 2). Samples were accelerated aged in different periods before recycling.

Table 1: *Number and size of ink particles and the area they occupy on handsheet after disintegration of prints made on fine art glossy paper*

Sample	Total number of particles	Particles >=0,04mm^2	Particles <=0,04mm^2	Total area mm^2	Area with particles >=0,04mm^2	Area with particles <=0,04mm^2
Sample 1 non aged	3151	154	2997	36,532	8,751	27,782
Sample1 aged 10 days	5008	194	4814	58,992	10,642	48,351
Sample 1 Aged 20 days	5631	329	5302	70,459	19,496	50,963
Sample 1 Aged 30 days	6337	411	5926	86,22	25,269	60,952
Sample 2 non aged	6550	644	5906	107,993	43,444	63,948
Sample 2 aged 10 days	6766	592	6177	102,447	39,238	63, 208
Sample 2 aged 20 days	7237	517	6720	103,414	33,835	69,579
Sample 2 aged 30 days	8330	860	7470	142,745	61,364	81,112

It is visible from the results that the total number of all ink particles on handsheet after disintegration in the first phase in the recycling process is increased. Generally speaking the particles <=0,04mm^2 prevail. Similar trend, that is, increase of area the particles occupy on handsheet can be seen in relation to the increase of print ageing period. The even more expressed difference exist on prints made with inks with greater amount of renewable raw material in the relation to the number of particles on handsheet and the characteristics with regard to the duration of the print ageing period for recycling

In table 2 the results of image analysis of handsheet after disintegration of prints produced with inks with greater amount of the renewable raw material are presented

Table 2: *Table and size of ink particles and the area they occupy on handsheet after disintegration of prints on different paper types made with the ink with greater amount of renewable raw material.*

Sample	Total number of particles	Particles >=0,04mm^2	Particles <=0,04mm^2	Total area mm^2	Area with particles >=0,04mm^2	Area with particles <=0,04mm^2
Fine art paper gloss, non aged	6550	644	5906	107,993	43,444	63,948
Fine art paper gloss, aged 30 days	8330	860	7470	142,745	61,364	81,112
Ofsset,uncoated non aged	14933	295	14638	141,573	31,27	110,303
Ofsset,uncoated aged 30 days	15979	477	15502	151,697	27,541	124,156
Ofsset, coated non aged	10123	361	9762	106,113	20,533	85,581
Ofsset, coated aged 30 days	12582	677	11905	140,827	35,395	108,609

The influence of the printing substrate on detaching of ink particles from the fibers in the disintegration process can be seen. Greater number of particles on handsheet after disintegration can be noticed on uncoated paper. The mechanism of ink detaching from the printing substrate can be observed by means of a microscope. The process of penetration and adsorption influence on the netted structure of paper is present on uncoated papers. On coated papers, the ink particles are detached together with the coating in the disintegration process, as it can be seen in figure 1 and the ageing process of prints influences the effectiveness of the recycling process, as it is shown in figure 2.

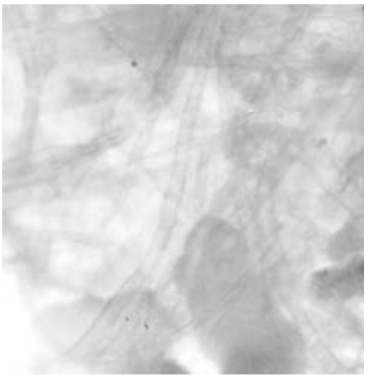

Figure 1: *Ink and coating particles in recycling of prints made on coated paper*

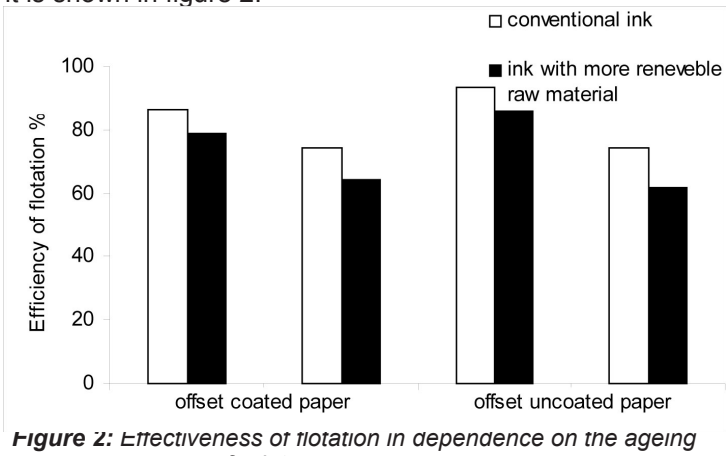

Figure 2: *Effectiveness of flotation in dependence on the ageing process of prints*

The results confirm weak recycling effectiveness of the aged offset prints. They can be explained by oxidative processes in which the chemical interactions between ink and paper are increased. They are explained by FT-IR spectra[7]. Except that, the presence of aldehyde resins in ink which cause networking is essential. With time, such species can induce covalent bonds between ink and cellulose fibers over the oxidative polymerization.

4 Conclusion

It can be concluded from the research results that print ageing is favourable to the increase of ink particles number on handsheet made after disintegration. The particle size is <=0,04mm^2. The number of particles and the area they cover on handsheet is the biggest in the frame of the experimental conditions in the case of print recycling with the ink with greater proportion of the renewable origin, which influences the recycling effectiveness. The presence of interactions between ink and fibers is the most important segment in the investigation strategy of deinking process effectiveness of the aged prints.

5 References

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