



## RECYCLING OF THE WASTE PAPER AND THE HANDSHEETS FORMING

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**Abstract:** *The results of the image analysis of handsheet obtained by different formers are presented in this paper. Handsheets are formed from the fibers obtained from the recycling process of prints produced in digital technique based on electrophotography with liquid and solid toner. The investigation results can be applied in the production of the recycled papers, and in the design of graphic products taking into consideration the postulates of the sustainable development.*

**Key words:** *digital printing, recycling, handsheet formers, image analysis*

### 1. INTRODUCTION

The paper making procedure is inevitably required to measure the various changing parameters of process control (Holik, 2006). Control with regard to drainage, retention and formation of sheets is important in terms of productivity and quality of final products (Swerin & Mahler, 1996).

Drainage property in wet-end stage means the degrees of dewatering of paper stock. If the drainage of wet-end part is not good, insufficient dewatering may cause the problem regarding the reduction of paper making productivity. It can be also a reason of poor physical properties of paper (Switzer et al. 2004).

When the retention is low it results in the accumulation of fines and contaminants in white water. Except that the bed formation as a result of increased consistency can be expected.

Unsuitably flocculation can influence the paper formation and time lowering properties of paper like printability, opacity and strength (Huber et al., 2004).

The investigation results of the application of well known handsheet former Rapid Köthen Sheet Machine and laboratory sheet former on optical characteristics of sheets made from the recycled fibers obtained from the digital technique based on electrophotography are presented in this paper. In the scientific sense the work is a contribution in the area of equipment like handsheet former and the mechanism of the waste paper recycling. The investigation results can be applied in the production of the recycled papers, in formulation of new printing materials and in the design of graphic products taking into consideration the postulates of the sustainable development.

### 2. EXPERIMENTAL

The prints for analysis made on machine Xerox DocuColor 5000 (powder tone is the two components one and consists of polymer, pigment, and the carrier of iron oxide) and digital offset machine Turbo Stream HP Indigo (ElectroInk contains about 5% monomer pigment paste, about 94% volatile mineral oil and about 1% agents for increasing electric conductivity).

To see the influence of the indirect electrophotographic printing on the effectiveness of the flotation of prints and the quality of the secondary raw material, one series of prints was made by varying the voltage of the offset cylinder (series 1).

For prints recycling the method of alkaline chemical deinking flotation was used, which was described in details in the previous work (Bolanca Mirkovic, 2009). Four series of sample were made in relation to the time of the disintegration process (10 min- marked by 10, 20 min-marked by 20, 30 min-marked by 30, and 40 min-marked by 40). Two flotations were done in these processes.

The handsheets before and after flotation were made using the Frank Rapid Köthen Sheet Machine (marked by A), and the laboratory sheet former (Pulp and Paper Institute, Ljubljana; Slovenia) (marked by B). Standard ISO 5269-2 was used for sheet formation.

The Rapid Köthen Sheet former machine is built for fully automatic and manual formatting (Fig. 1.-A). After preparing the pulp sample, the process is started and water is pumped into the stock container. The suspension is agitated with compressed air, and then is allowed for the turbulence to cease. After dewatering the sheet is finished and automatic drying process begins.



Fig.1 The Rapid Köthen Sheet former machine (A) and Handsheet former for A4 sheet size (B)

Handsheet former presented in Fig 1 has screen size of 210 x 297 mm (Pulp and Paper Institute, Ljubljana). The former is filled with water and the suspension is evenly spread on the screen. For suspension homogenization the part with holes is used. After that the water is let out of the machine and the formed handsheet remains on the screen. The sheet is detached from the screen by means of a roller and paper of great absorbency, passing the roller carefully in one direction. The sheet is detached from the screen and dried in the air.

Residual specks which include, toner particles number and area were assessed with image analysis software Spec\*Scan, Apogee System. This system is utilizing scanner to digitize image. Threshold value (100), white level (75) and black level (65) were chosen after comparing computer images to handsheet.

### 3. RESULTS AND DISCUSSION

Tab. 1. presents the results of the image analysis of handsheets obtained by formers presented in Fig 1. The prints with different disintegration times were used for recycling.

Samp.	Total count specks	Count >0,04 mm <sup>2</sup>	Count <0,04 mm <sup>2</sup>	Area mm <sup>2</sup>	Area >0,04 mm <sup>2</sup>	Area <0,04 mm <sup>2</sup>
10AD	718	83	635	14,71	9,04	5,67
10BD	705	76	629	14,70	9,29	5,41
10AF	342	75	267	11,69	8,50	2,90
10BF	340	66	274	10,90	8,00	2,91
20AD	729	67	662	11,95	6,48	5,47
20BD	741	63	678	10,20	4,75	5,46
20AF	121	23	98	3,80	2,85	0,95
20BF	127	18	109	3,50	2,36	1,14
30AD	781	65	716	12,73	6,74	6,00
30BD	794	58	736	12,20	6,14	6,06
30AF	123	27	96	3,26	2,33	0,93
30BF	90	20	70	2,58	1,80	0,78
40AD	815	64	751	11,72	5,23	6,49
40BD	835	54	781	11,32	4,48	6,84
40AF	77	12	65	2,77	2,26	0,51
40BF	69	18	51	2,76	2,41	0,36

Tab.1. Specks count and area on handsheet formed from fibers after disintegration (marked by D) and after flotation (marked by F) by using the earlier mentioned formers

increasing the disintegration time from 10 to 40 min the flotation effectiveness increased. When the Rapid Köthen Sheet former mashine was used for sheet formation, for 79,5% lesser speck number was found after flotation on handsheet, while using the other sheet former this number was smaller, it was smaller for 77,5% .

From the presented dirt content histogram it is visible that in five dirt spot sizes for handsheet former A and B, the number of specks is equal.

The results show that the second flotation does not influence so much the effectiveness flotation as it was found out in the case of time disintegration increase from 10 to 40 min (Tab. 2).

Samp.	Total Count speck	Count >0,04 mm <sup>2</sup>	Count <0,04 mm <sup>2</sup>	Total area mm <sup>2</sup>	Area >0,04 mm <sup>2</sup>	Area <0,04 mm <sup>2</sup>
BF1	331	56	275	10,889	8,133	2,756
BF2	315	51	264	8,201	5,597	2,604

Tab. 2. Specks count and area on handsheet formed from fibers after the first and the second flotation by using the former A with the screen of A4 size

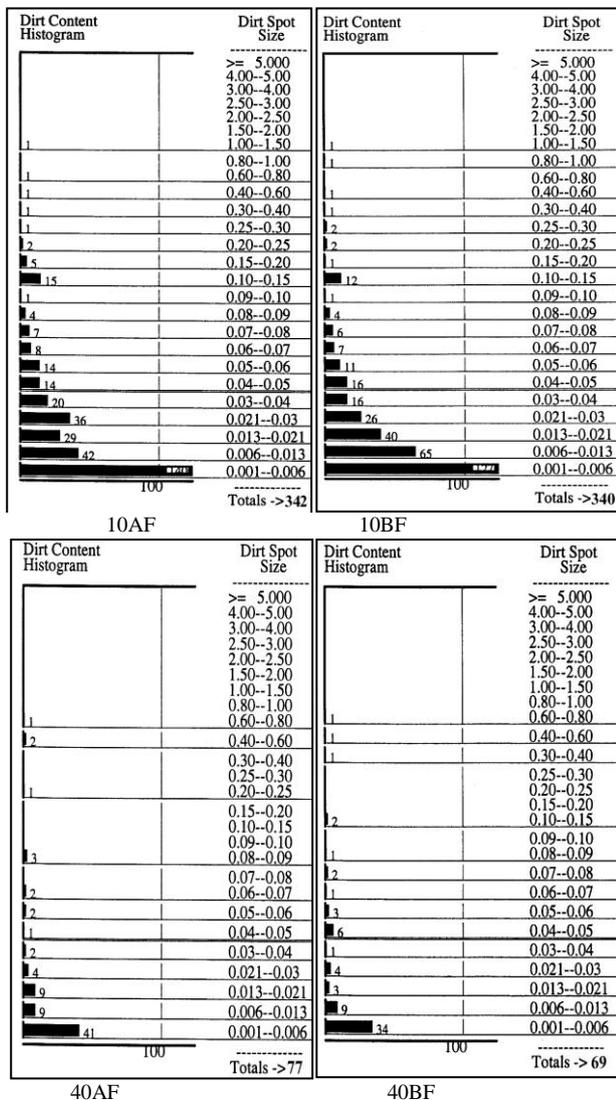


Fig.2. Dirt content histogram for handsheets made from the recycled fibers by using former A and B

The investigation results show that in the frame of the described experimental conditions, in great majority of the cases the dirt content on the sheets formed with Rapid Rapid Köthen Sheet former mashine is somewhat greater in regard to the other former. The aberration range from 0,02 to 4.2 % . By

The calculated effectiveness of the second flotation in regard to the first one is 28,7%. The difference in results in regard to the sheet formation by using the different formers is within the limits of the earliest presented results.

The difference in speck count and area between the screen and felt side is determined. Greater speck count and area of about 8% was notice on the felt side of handsheet. Greater differences in regard to the used handsheet formers when there are specks which did not belong to the size classes between 1,00 – 1,5 mm<sup>2</sup> and >= 5 mm<sup>2</sup> were not found out. Greater differences can appear when sheets are prepared from the fibers after recycling of prints made by indirect electrophotography in combination with some substrates (series 1).

#### 4. CONCLUSION

By the described investigations the characteristics of different machines for sheet formation on the example of the recycling of digital prints based on electrophotography made with solid and liquid toner are compared. By image analysis, no significant aberrations in characteristics of handsheet produced by the recycled fibers by using different formers were found.

The obtained results point at the need for further investigation including the experimental design and creation of the statistic models.

#### 5. REFERENCES

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