NDT-A COMPARISON BETWEN TWO IMAGE ANALYSIS SOFTWARE TOOLS

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Abstract
Non-destructive testing method scanner based image analysis is used for dirt speck measurement for the evaluation of prints deinkability in waste paper recycling process. The measurement of dirt specks number and area and size classes distribution in undenked and deinked pulps are presented. Two image analysis software tools Spec*Scan, Apogee System and Proton in measurements are used.
As the investigation result, the influence of the printing technique, printing conditions, toner and paper kinds on dirt specks number, area and size classes distribution in both undeinked and deinked pulps has been established. The image analysis results obtained for the software Proton are somewhat greater in regard to those obtained for the software Apogee, but the trend is very similar.

1. Introduction

Nondestructive testing are noninvasive techniques to determine the integrity of a material with the aim to locate and characterize the state of material and eventual errors or quantitatively measure some characteristic of an object. NDT is used in a wide range of industrial areas (power generation, aerospace, automotive, railway etc). Reliability of a nondestructive testing method is an essential issue. Each these method has its own set of advantages and disadvantages and because some are better than others for a particular application.
As nondestructive testing method the image analysis of dirt specks in undeinked and deinked pulp is an important measurements for the evaluation of impressions denkability in waste paper recycling process (Renner K., 2000) . Measurement of dirt specks number, area, size classes distribution, diameter and sharp is necessary for research on deinking process conditions or to compare deinkability of impressions from different printing techniques, or with different inks or paper. Image analysis is also necessary for the evaluation of macrostickies generated by the fragmentation of adhesive applications in recycling process. Many authors have studies the image

analysis technique (Trepanier R.J., et al. 1997, Göttsching L. et al. 1999, Bolanca Mirkovic I. 2005). Image analyzers are divided into dedicated and research instruments. Research instruments are coupled to computer software with an optical microscope and a CCD camera. These instruments are producing results for allowing smaller particles to be analyzed.
Except the mentioned, the application of the image analysis on stickies concentration was monitored (Doshi M.R., Dyer J.M., 2000). Rosenberger and Houtman use the system of the image analysis for measuring in 24 bit colour. They classify the contaminants on the basis of the colour as the residual ink, coloured contaminants and dyed particles (Rosenberger, R.R., Houtman C.J., 2000). In the colour of the image analysis the contaminants that have adsorbed the hydrophobic dye can be distinguished from the inks and dirts. In this case two scans are necessary, the scan handsheet before dying to determine the dirt and a scan of the dyed handsheet to determine hydrophobic contaminants and dirt.
The application of image analysis of dirt speck in undeinked and deinked pulp for the evaluation of impressions denkability for prints from different printing process with different inks and paper is presented in this paper. The comparison between the two image analysis software tools is discussed.

2. Experimental

The prints of the digital printing techniques with liquid and dry toner are used, (printing machines HP Indigo and Xerox). One sample series was printed in the conventional offset technique on the printing machine Heidelberg. The test form was designed by using the standard ISO and ECI templates and it was created in the application Adobe Photoshop. Except that, the test contained the standard CMYK step -like wedges in the range from 10 to 100% screen value.
Printing substrates were the mat fine art papers of 200 g/m^2 and 280 g/m^2 basis weight. The corresponding thickness values were 0,185 mm and 0,280 mm respectively. The printed samples underwent the alkaline deinking flotation process. In the process of the chemical deinking, the following chemicals 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. The handsheets were made using a laboratory sheet former, according to standard TAPPI method T 205. The brightness of the handsheets ware measured according to ISO standard method. Dirt specks ware assessed by means of image analysis. In general, the principle of this method is the usage of the difference in contrast between the particles of dirt specks and the substrate. The image obtained by a flat-bed scanner is digitally converted into pixels whose size depends on the visibility field and the image depends on the scanner resolution. Identification of the dirt specks is based on the differences in gray values. The value between 0 and 255 is given to each pixel in accordance with its reflectance. The image segmentation converts the digitalized gray value image of the camera to a binary, black-and-white, image. In this way all the pixels with the gray value above the determined threshold value are identified as the dirt specks and they get the value 1 in the binary image. Pixels with gray values below the threshold are considered as background. The image analysis ends in measuring the dirt particles and in producing the data output. Dirt specks analysis procedure is presented in figure 1.

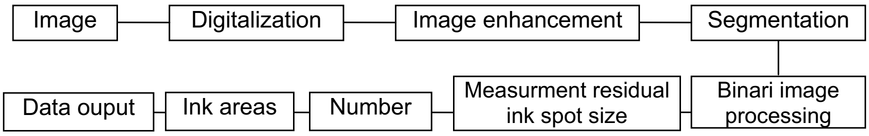
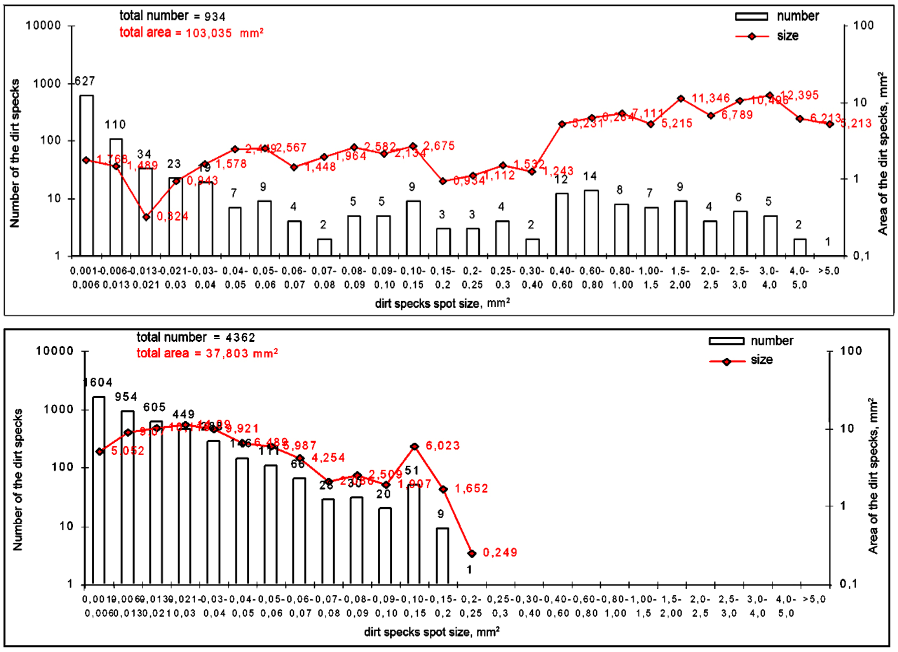


Figure 1: Dirt specks image analysis procedure

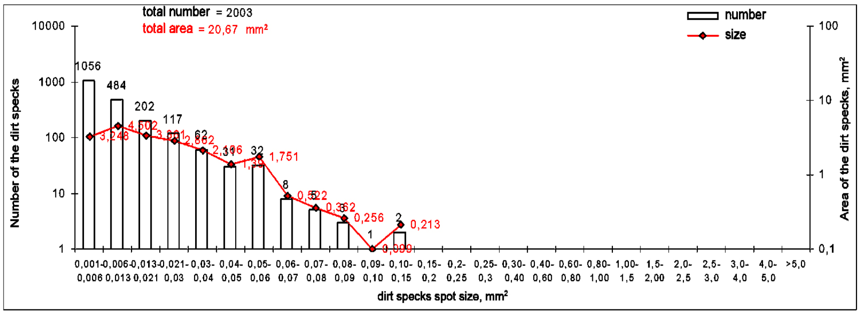
Residual ink particles size (area) and number were assessed with image analysis-based software systems: Spec*Scan (Apogee System). Spec*Scan system utilizes a flat-bed scanner Epson Perfection 2400 Photo to digitize image, its resolution was set to 600 dpi. Three lab handsheet samples for each combination of settings were scanned on both sides. Size intervals were defined according to TAPPI methods T 213 and T 437. Threshold value (100), white level (75) and black level (65) were chosen after comparing computer images to handsheets. Residual dirt speck number and area assessed with two image analysis scanner based software systems: Spec*Scan (Apogee System) and Proton (local manufacturer). For comparison between the two image analysis software tools the multifactor experimental design was used.

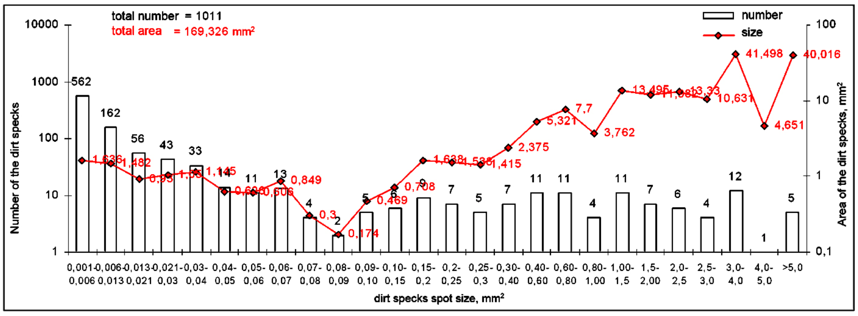
3. Results and discussion

One of the main observation objects in evaluation of deinkability in the domain of the quality parameters of the secondary raw material is the determination of optical cleanliness.

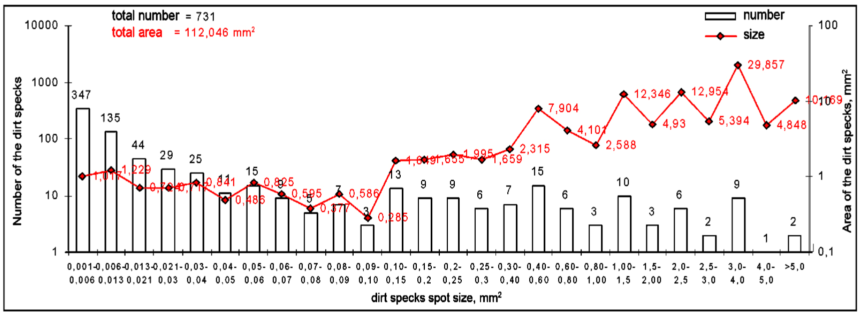


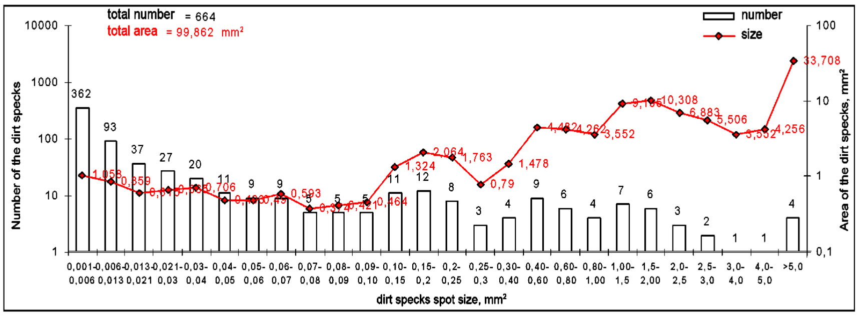
a) digital and conventional technique of printing



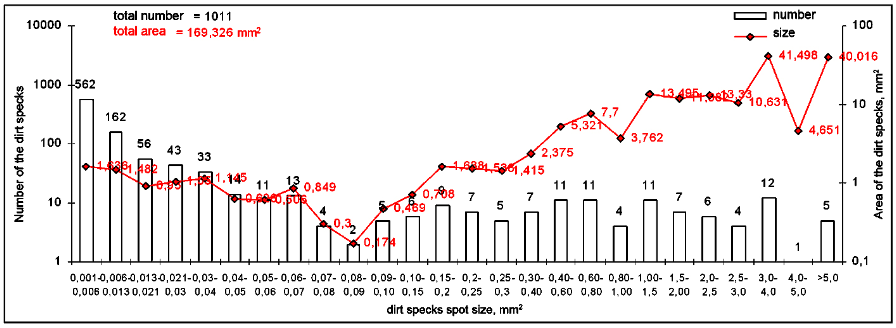


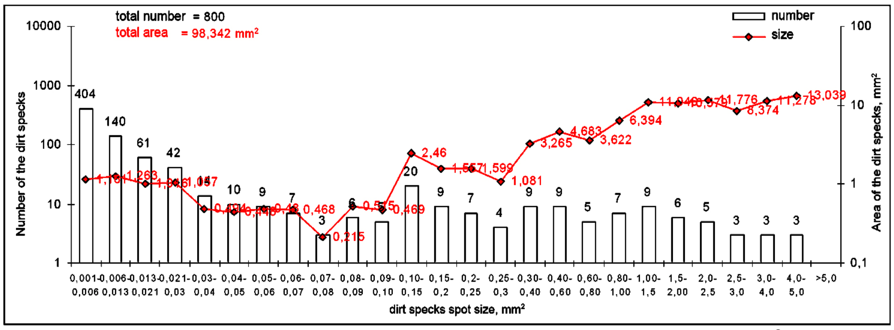
b) digital printing technique with dry and liquid toner (undenked laboratory handsheets)





c) digital printing technique with dry and liquid toner (deinked laboratory handsheets)





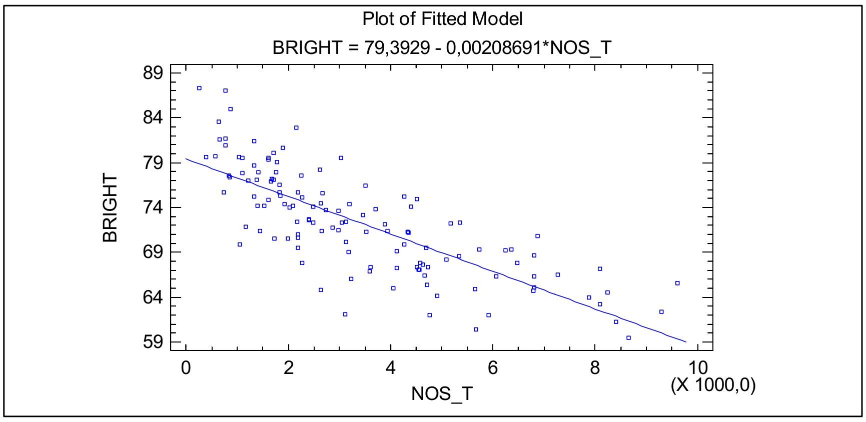
d) digital printing technique on paper with different basic weight: 200g/m^2 and 280g/m^2

Figure 2. Image analysis results in the function of waste paper printing technique, kind of paper and ink

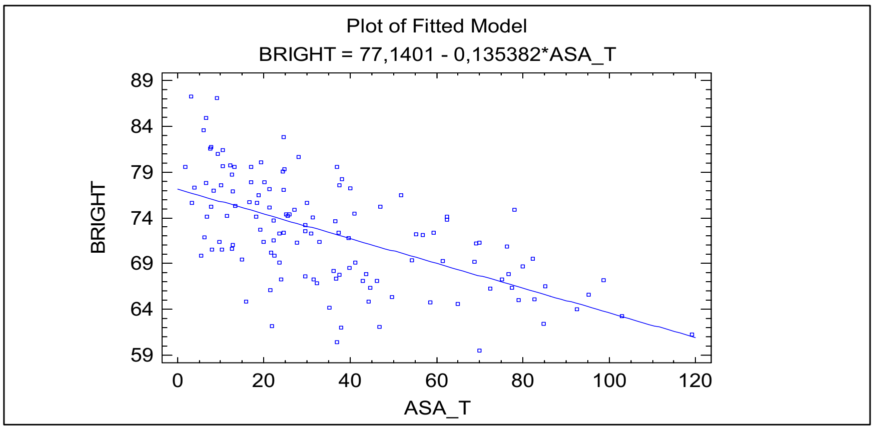
In figure 2, the results of the image analysis of the disintegrated pulp from the different printing techniques (digital technique and conventional offset technique), digital printing technique using the different toner types (dry and liquid toner), digital printing techniques on different printing substrates (papers of different basic weight) are presented.

The investigation results show that the influence of the system variables can be observed with a scanner based image analysis system in the microscopic and macroscopic area. Dirt specks including ink particles in the undeinked and deinked laboratory handsheet form an optical contrast to the brighter sheet background. As the analysis result the influence of the printing technique, toner and paper types on dirt specks number, area and size classis distribution in both undeinked and deinked pulps can be noticed. The results of the image analysis are especially important in the cases of determining the particles size in the visible area which cause the optical non-homogeneity and which decrease the efficiency of the particle removal in the flotation process which follows when they are not in the optimal size areas.

In order to find out the correlation between the image analysis results and the conventional optical parameter, the experimental design and multi factor analysis of variants was used (figure 3).



a) total number of dirt specks



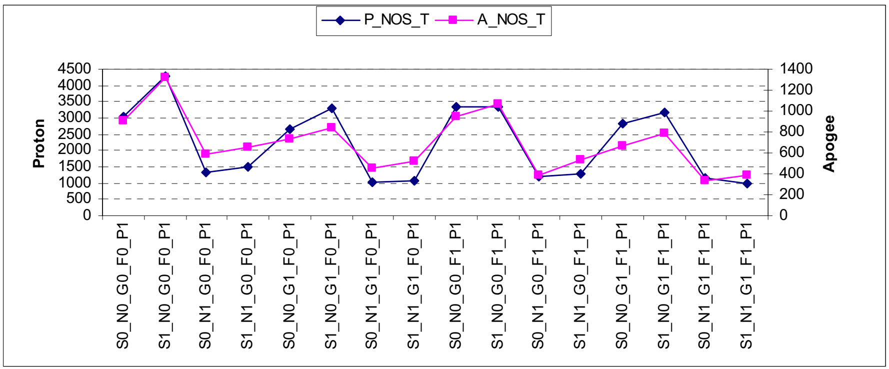
b) total area of dirt specks

Figure 3. Correlation between the brightness and the total number and area of dirt specks

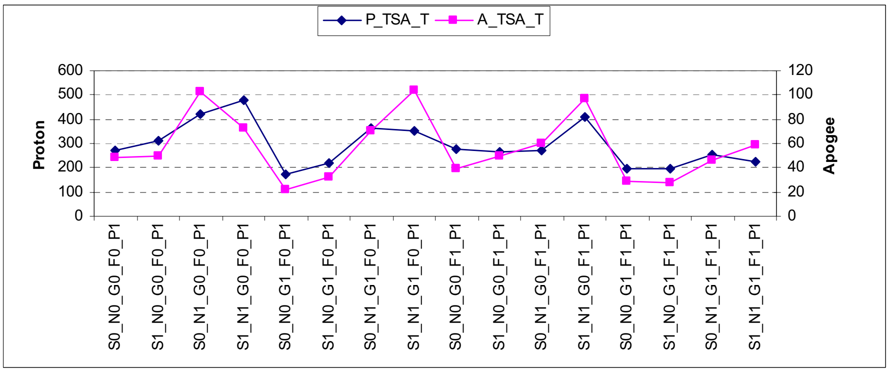
Among the broad investigations in this area, the correlation results among the total number and the area of dirt specks and brightness were chosen for the presentation. When the correlation is monitored including the total number of particles of all class sizes the results show somewhat grater correlation of brightness with the number of dirt specks than the one with the area in the described experimental conditions. It is important to emphasize that the correlation is more attributed by the particles smaller than 0,04 mm^2, i.e. by those in the invisible particle range, so the correlation is stronger in this case.

Flotation contributes to the decrease of ink dirt specks area. The investigation results show that the removal efficiency is about 40% for the digital prints made by liquid toner, about 80% for the digital prints made with stiff toner, and in the determined printing conditions it is about 90%, while in the case of the conventional offset prints the value is over 90%.

In figure 4 the image analysis results from two software tools Apologee and Proton are presented.



a) total number of specks



b) total specks area

Figure 4. Comparison of image analysis tools for total number and area of specks

The image analysis results obtained with the software Proton are somewhat greater in regard to these obtained with the software Apogee, but the trend is very similar. For the usage of image analysis with the aim for evaluation the residual dirt specks in waste paper recycling process the system calibration is important as well as the defined conditions in order to achieve the result reproducibility. In this method the setting of an appropriate threshold value is the criterion for differentiation of features in the foreground from their background. The threshold value can be determined by the operator on the basis of his subjective evaluation. There is the possibility for creating the function for calculating the threshold values corresponding to all the range of grey values, which decreases the subjective influence of the operator.

4. Conclusion

On the basis of the investigation results it can be concluded that the software Proton and Apogee do not give the same results but the trend is very similar. Scanner based image analysis of dirt specks as the nondestructive testing method is important for the evaluation of the printed product deinkability not only in the domain of estimating the influence of the printing technique, kind of paper and ink but in the printing conditions too.

Regarding the great number of influential factors of the system, the image analysis of dirt specks with the usage of the experimental design and with creation of statistic models in the scientific sense can contribute in the segment of deinking mechanism investigation and determination of influence lawfulness of the defined variables on the chosen property of the experimental units.

5. References

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