The Papers Printing Quality Complex Assessment Algorithm Development Taking into Account the Composition and Production Technological Features

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Abstract. Paper is one of the printing system key components causing the high-quality printed products output. Providing the printing companies with the specified printing properties paper, while simultaneously increasing the paper products range and volume by means of the forecasting methods application and evaluation during the production process, is certainly a relevant problem. The paper presents the printing quality control algorithm taking into consideration the paper printing properties quality assessment depending on the manufacture technological features and composition variation. The information system including raw material and paper properties data and making possible pulp and paper enterprises to select paper composition optimal formulation is proposed taking into account the printing process procedure peculiarities of the paper manufacturing with specified printing properties.

1. Introduction

In the modern market environment while producing the printing and packaging products the competitiveness defined by the quality depending on the production capabilities and regulations is strongly influenced by the printing carrier (material) and paint interaction.

The current standard [1] regulates the printed offset products quality indicators requirements. This way provides only limited amount of reference paper types which makes the printouts quality assessment in the small and medium-volume manufacturing environment difficult.

Given a large variety of the printing system components, the lack of new materials printing and technical properties data and taking into consideration the consumers’ expectations about the printed image quality, the offset printing quality forecasting problem is supposed to be of great economic importance and relevant. The problem solving requires the evolution and development of the known and new quality indicators assessment methods both printing system components and a printout.

2. Problem statement

The authors of the papers [2, 3] indicate that during the printing ink transfer, the structure characteristics of the print material, the shapes of the pores and the holes being present on its surface play a dominant role. However, in papers [2, 3] the quantitative assessment data of the ink on paper transfer coefficients in the contact surface are not provided.
The fundamental principles on the role of the structure and its influence on the paper properties and printout quality were set forth in papers [4-7]. It should be noted that in the offset printing process, when paper wetting, the surface fibers swell and as a consequence its roughness slightly increases thereby reducing the printout intensity. In addition, large paper surface irregularities (cardboard) can lead to the large offset rubber deformations, and this contributes to the printout printing (elements) sizes increase. When offset printing on the rough paper the reduced printout intensity is observed, this is due to the fact that various surfaces types reflect light differently. Roughness can theoretically cause the local paper inhomogeneity on moisture.

The expert evaluation methodology according to which the expert group members assess 10 printout specimens quality by means of the pairwise comparison was developed by the authors of the paper [8]. The expert evaluations results are processed by using the fuzzy sets theory. However, it should be noted that experts are able to distinguish and identify the printouts quality differences obtained in many ways only with test elements magnification which is various for various apparatuses, and the printed test element (letter) quality perception character without magnification can be entirely changed when evaluating with a high magnification.

The printouts examination method to determine the quality level taking into account the paper quality fluctuations at the micro level was developed by the authors [9]. The method application is also difficult as it requires the special equipment (TAPIO Paper Machine Analyzer and Tapio Printability Sensor) designed for unprinted points quantity rapid measurement. On the basis of the variables of different origin combined influence on the printouts quality conducted studies the authors [11-14] emphasize among other factors the paper sheet density irregularity impact on the paint penetration.

Therefore, the wrong choice of paper type caused by the lack of reliable data on its composition and surface characteristics can be one of the spoilage primary reasons and as a consequence the impossibility to satisfy customer and consumer requirements ones. The proposed solutions represent, in most cases, the individual attention to studying the printing (material specific factor influence on the printing quality.

The produced paper range expansion and making its properties meet the international standards requirements is the topical scientific and practical problem. In recent years in the Republic of Uzbekistan new types of paper have been developed including the paper made from cotton lint (CL). The results of the runability individual parameters interrelation with the printing quality indicators were represented by the authors [15-18].

Modern quality management is based on the fact that quality management activity cannot be effective after the products are produced, this activity should be carried out both at the preproduction stage and during the manufacturing process.

This proves the necessity of developing the paper printing properties assessment models making possible pulp and paper enterprises select paper composition optimal formulation taking into account the printing process procedure peculiarities of the paper manufacturing with specified printing properties. The high priority objective is printing quality on papers complex assessment algorithm development taking into account the composition and production technological features.

3. Results and discussion
To forecast the printing quality before the printing process on papers adding SFM (secondary fibrous materials), the multilevel system being the development of the conception «raw material - paper - printout», which is presented in Figure 1, is proposed.

According to the scheme analysis the regularities of the interrelation between the printing quality and (paper properties) define:
• fibrous semi-finished products obtaining and processing methods;
• paper printing and technical characteristics depending on the composition;
• printouts printing quality indicators.
Figure 1. The «raw material - paper - print» system elements interrelation scheme.

Considering the fact that (paper printing properties) varies as a result of the introducing other semi-finished products into the composition, in this paper to improve the paper (printing properties inability based on cellulose from CL () and to give it specified (printing properties), fibrous semi-finished products from wastes (SFM) were selected taking into consideration the fibres structure.

For the comprehensive printing quality assessment the assessment model was developed and the algorithm was recommended, the scheme of which is shown in Figure 2. The model reliability was defined by the multiple rank correlation method.

The developed algorithm practical implementation is shown in Figure 3 which represents the comprehensive (printing properties assessment results adding SFM in the form of the radar chart with markers. This makes possible to illustrate the indicators variability simultaneously in several directions.

The paper properties comprehensive assessment diagram analysis revealed that paper whiteness is within the standard limits (from 72 to 91%). The influence investigation results of adding SFM on nontransparency values defining the paper printing properties confirmed the paper suitability for the multicolor products one-side printing, while for the double-sided printing without image show-through and strike-through the additional sizing or composition or filler quality changing is necessary.

Porousness identical values provided by kanaf cellulose (KC), licorice cellulose (LC) and natural silk waste (NCW) except wheaten cellulose (WC) adding into the paper pulp characterize the pores volume reduction and the reaction surface accessibility. The application of WC as an additive requires the composition careful selection or fibrous material processing optimal performance choosing.

When forming the paper layer, NCW short fibers fill the gaps between the CC long and flexible fibers (paper No. 2). In this case, the printout optical density equal to 1.5 is achieved at a paint layer thickness of 1.0 μm, whereas on paper No. 1 (CC 100%) this result is achieved at a paint layer thickness of 1.5 μm (Figure 4).
Figure 2. The comprehensive printing quality assessment algorithm.

Figure 3. The printing quality comprehensive assessment of paper adding BBM.
Figure 4. The dependence of optical density of the print from thickness of a paint layer on the paper (a) and kinetics of primary fastening of a paint layer on the paper (b).

The study results analysis showed that printed on papers with the addition of SFM printouts optical density meets the international standard requirements [1].

4. Conclusion

- The printing quality complex assessment algorithm based on the «raw material - paper - printout» system approach application, providing the specified paper printing properties (runability) with the addition of recycled fibrous materials (obtained in the Territory of the Republic of Uzbekistan) was developed.
- The recycled materials addition into the paper pulp was found out to reduce the primary ink fixation rate providing the ink fixation condition on the paper surface.
- The optical densities values of the printouts printed on papers with the addition of SFM are relatively equal to the machine-finished paper optical densities values (for example, offset paper No 1) according to the densitometric standards ISO 12647-2.

5. References

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