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Research area: Product aims
Paper, paperboard and board // Graphic papers

Key words:
Ink penetration, printability, coating design, hybrid printing

TITLE:

Simulation based optimization of coating design and coating composition for printing paper with improved printability through selected ink penetration

Background/Problem area

The market of printing products has changed fundamentally in recent years. Competition of new media such as online portals of classic print media etc. vitalized the market. To meet the growing demands in the future, more and more printers take an interest in hybrid printing technologies, i.e. technologies that combine conventional offset printing technology with Inkjet print heads. These printing technologies define specific requirements regarding the used paper and its coating. However, existing procedures for developing coating design and coating composition for printing paper that is well-suited for a particular hybrid printing process are based on purely empirical methods. This is associated with long development times, low throughput rates of the formulation development and high development and testing costs. Paper manufacturers lack appropriate applicable tools to implement innovative coating concepts (e.g. for combined printing applications) and to derive recommendations for improved coating formulations and coating designs.

Objectives/Research results

The aim of long-term planned research projects at PTS is to support the optimization of coating design and coating composition in respect of better printability by simulation tools. It should be possible to determine the required coating design (layers) and its formulation virtually on a PC and based on the demands of the specific printing procedure.

The current project aims at the development of a first module for the simulation-based optimization of a coating design with a defined ink penetration characteristic. It focuses on offset printing with small amounts of ink in the scope of personalized printing.

Starting point was the preparation of various single and double layer laboratory samples that represent relevant coating formulations. Transparency films have been used in addition to conventional paper substrate in order to study the coating itself. The short time behavior of the penetration processes has been investigated using different methods and several printing inks and fluids. Corresponding results serve as fundament for the development and validation of data-based PLS-models that predict significant properties of the pore structure (porosity, pore size), the coating layers and material constants (particle size, binder). These properties are in turn needed as input for the models that simulate the penetration and absorption processes. Corresponding models are built up as FEM-models based on the COMSOL software. Alternatively, models that base on the Bosanquet differential equation have been composed and implemented in the MatLab software. They simulate the movement of a liquid band in a capillary. In addition, the pore structure has been calculated based on the measurements of Hg porosimetry using the Pore-Core-software. Most of the investigations done so far considered single-layer coatings. Corresponding considerations for double layer are still in progress.

Provisional results show that the models provide good prediction of the expected qualitative progression and temporal relationship of penetration time for the individual fluids. The calculated penetration times are lower than the measured values for typical amounts of fluid. This is particularly relevant for the FEM-models. Nevertheless, the analysis of FEM-models shows that in general fluid transport is stimulated solely by capillary effects without additional force. Fluid movement stops as soon as the liquid has been drawn completely into the capillary.

Application/Economic benefits

The results will be available for users of the print products value chain (paper manufacturers, printers and suppliers respectively). In particular, small and medium enterprises (SMEs) in the areas of printing, packaging manufacturing, and chemical suppliers will benefit from the research results. The optimization of coating formulation could lead to the following technical and economic benefits:

- Cost savings of experiments
- Use of cost-efficient pigment combinations that cause the same printability
- Cost and time savings for the printing industry through papers with combined printing suitability

Considerable advantages can as well be found in applications on pilot coaters. Compared to conventional approaches, a significantly larger number of variants can be studied in less time. Because of this much larger scope of experiments the use of modeling and simulation could bear creation of new paper qualities which so far is not possible due to the limitations of the experimental and empirical approach.

Period of time: 01.10.2010 – 31.12.2012

Remarks

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