Abstract

This thesis presents a grey-box model of the temperature and moisture content for each layer of the multi-ply paperboard inside the drying section of a paper mill. The distribution of the moisture inside the board is an important variable for the board quality, but is unfortunately not measured on-line. The main goal of this work is a model that predicts the moisture evolution during the drying, to be used by operators and process engineers as an estimation of the unmeasurable variables inside the drying section.

Drying of carton board is a complex and nonlinear process. The physical phenomena are not entirely understood and the drying depends on a number of unknown parameters and unmodelled or unmeasurable features. The grey-box modelling approach, which consists in using the available measurements to estimate the unknown disturbances, is therefore a suitable approach for modelling the drying section.

A major problem encountered with the modelling of the drying section is the lack of measurements to validate the model. Consequently, the correctness and uniqueness of the estimated variables and parameters are not guaranteed. We therefore carry out observability and identifiability analyses and the results suggest that the selected model structure is observable and identifiable under the assumption that specific measurements are available. Based on this analysis, static measurements in the drying section are carried out to identify the parameters of the model. The parameters are identified using one data set and the results are validated with other data sets.

We finally simulate the model dynamics to investigate if predicting the final board properties on-line is feasible. Since only the final board temperature and moisture content are measured on-line, the variables and parameters are neither observable nor identifiable. We therefore regard the predictions as an *approximation* of the estimated variables. The semi-physical model is complemented with a nonlinear Kalman filter to estimate the unmeasured inputs and the unmodelled disturbances. Data simulations show a good prediction of the final board temperature and moisture content at the end of the drying section. The model could therefore possibly be used by operators and process engineers as an indicator of the board temperature and moisture inside the drying section.

Keywords: Drying section modelling, multi-ply paperboard, moisture content, identification, grey-box modelling

TRITA-MAT-06-OS-01 • ISSN 1401-2294 • ISBN 91-7178-302-4