Abstract

The thesis presents a grey-box model of the moisture content in each layer of the board inside the drying section of a paper mill. The distribution of the moisture inside the board is an important variable for the board quality variables, but is unfortunately not measured on-line. The main goal of this work is to develop 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 system. 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 in a drying section.

The semi-physical model, based on the heat and mass transport in the cylinders and in the board, derives the temperature of the cylinders and the board temperature and moisture content inside the drying section.

A major problem encountered with the modelling in a drying section is the lack of measurements to validate the model. Consequently, the correctness and uniqueness of the estimated variables or 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 model structure is 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 or 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 be used by operators and process engineers as an indicator of the board properties inside the drying section.

Keywords: Paper making, Drying section modelling, Moisture content, Grey-box modelling, system identification