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Simulation in papermaking – a way to reduce costs

Executive Summary

Due to increasing energy prices efficiency of the paper machine drying section is becoming more and more important. Cost saving potentials can be revealed by simulating the mass and energy flux in the paper machine drying section and heat recovery system. An energy savings project with several paper mills identified energy saving potentials between 2-6 % of drying energy, each having a return of investment of less than one year.

Introduction

The drying part of paper making is an extremely energy consuming process. Energy savings in the drying group are directly related to a reduction in manufacturing costs and therefore provide competitive advantages in the face of an ever more challenging economic environment.

In the current projects the key issue to identify optimisation potential turned out to be detailed process knowledge of the entire drying process, i.e. the paper machine drying section and the heat recovery system. Usually modifications of paper drying are carried out only in the drying section without appropriate updating of the air flow in the heat recovery system. This often leads to excess air leakage in the drying hood, unnecessarily low moisture content of exhaust air and inappropriate flow rates in drying section and heat recovery.

Methods

Consulting Fisera, in cooperation with the Institute of Paper, Pulp and Fibre Technology (University of Technology Graz), developed a simulation model based on the physical laws on mass- and heat transfer which accurately reproduces the mass and energy flow in the paper machine and the heat recovery system.

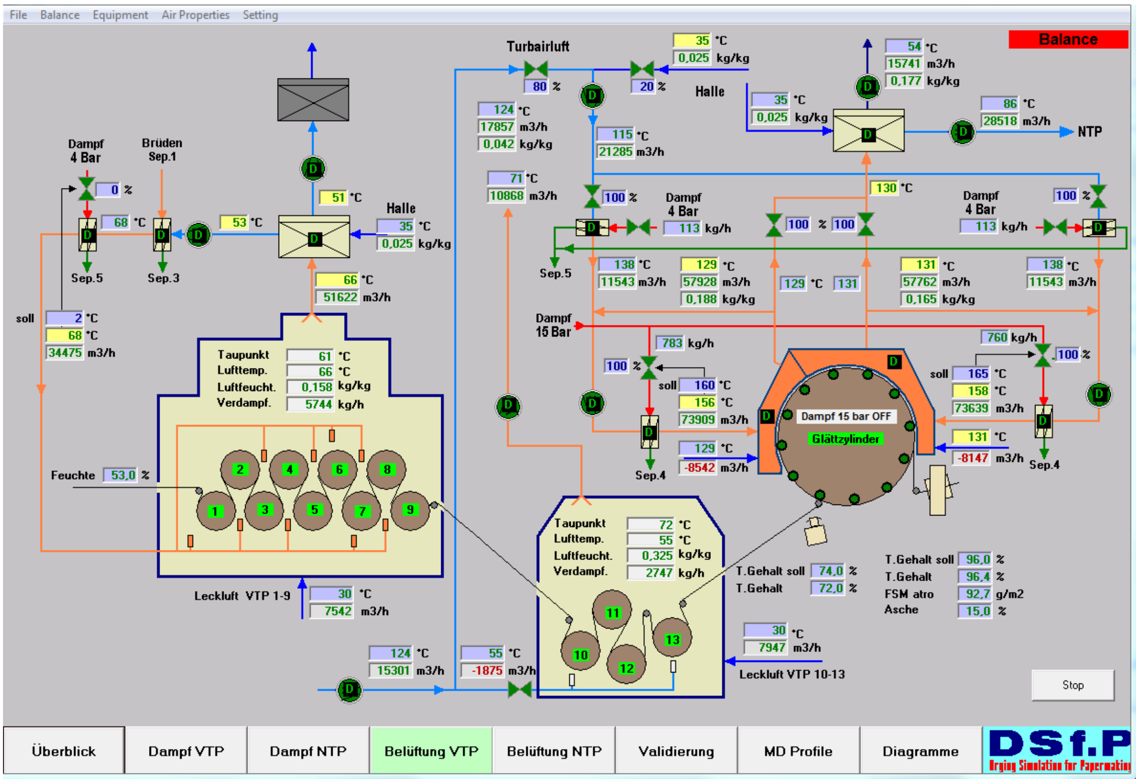

Figure 1: The simulation model's user interface is based on operator monitor screenshots and is therefore easy to use without specific training.

The user interface of the model is based on operator monitor screenshots (Figure 1) of the modelled paper machine. The simulations are therefore easy to perform, even for untrained persons. All relevant production parameters like steam pressure, overall steam consumption, machine speed or paper dry content can be simulated and were validated to have only small deviations compared to values measured on the actual machine.

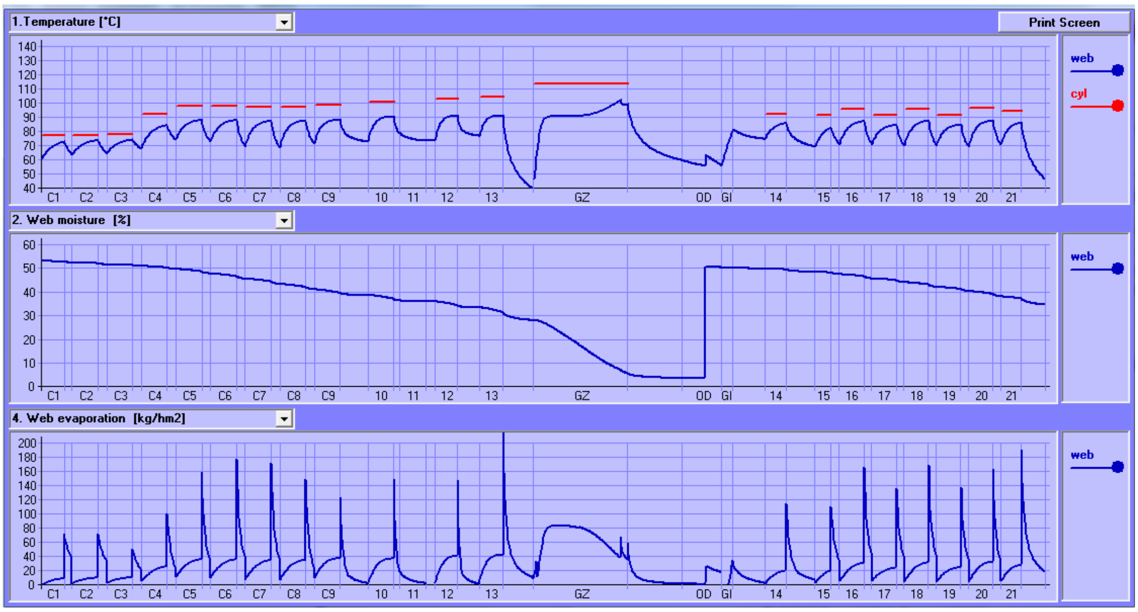

Figure 2: Simulation model results. The top chart shows the temperature of the web (blue) and the drying cylinders. In the middle the development of the web moisture along the paper machine is shown. The last graph shows the evaporation rate at each drying cylinder.

The simulation model provides various MD profiles like temperature of the web and cylinders, humidity of web and air or evaporation rates of each cylinder. Examples of MD profiles are given in Figure2. The profiles shown are from a model of a paper machine with a Yankee cylinder and a coating station.

Model validation has been conducted for several paper grades, each one in different operating points and basis weights. Therefore comprehensive measurements of the air streams (temperature, humidity and mass) have been undertaken and the results have been compared to the model results.

Results and Discussion

In the last two years 9 paper machines have been simulated: Mondi Packaging Frantschach (2 PMs), Mondi Packaging Steti (4 PMs), Hamburger Container Board Pitten, Lenzing Paper and Laakirchen Papier AG.

The energy savings revealed will be shown in the presentation, five case studies will be presented. The savings potential shown by the simulation model is between 2% and 6% of total drying energy. Often the savings could be realised without any investment costs, just by identifying more appropriate machine settings. An example for such zero-investment savings is the reduction of air leakage in the drying hood. Measurement of the air balance in one of the mills had shown that leakage air was more 60% of total air flow in the drying hood. The reason were found to be clogged heat exchangers leading to a far too small supply air volume. Hydro cleaning and chemical cleaning of the heat exchangers increased the supply air volume drastically and the hood air leakage flow decreased. As a result of this the temperature in the hood increased by about 10°C. Reducing the temperature to the former level, the steam consumption for heating up the supply air could be decreased, leading to steam savings of 6000 t/a.

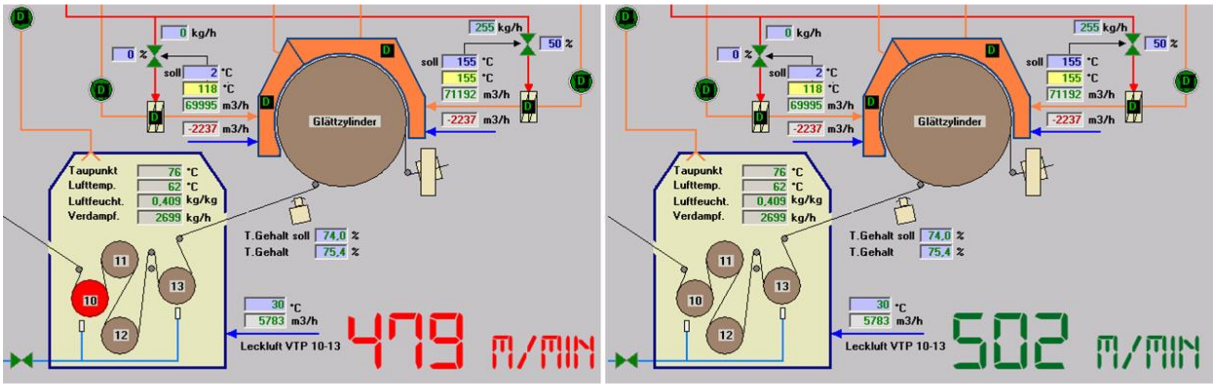

Figure 1: Simulated shut down of a drying cylinder. On the left side one can see the reduced speed of 479 m/min compared to 502 m/min with the cylinder running.

As mentioned above, the simulation model can predict the increase in drying capacity by adding new drying cylinders to a machine. Also the reduction of cylinders, e.g. due to a machine rebuild, can easily be simulated by switching off individual cylinders in the simulation, see Figure 3. The simulation model is able to calculate the decrease in machine speed and production capacity with high accuracy.

Another application of the simulation models is the possibility of simulating the effect of new machinery like additional cylinders, impingement/IR dryer, shoe press etc. In this case the model can be used to study different scenarios for machine rebuilds with respect to machine speed or energy consumption.

Conclusions

We have applied a computer model of mass- and heat transfer in the drying section and heat recovery system of several paper machines. Energy balances based on model simulations and extensive measurements of air temperature, moisture and flow rates in the machine were able to reveal potential energy savings. In a series of cases at different paper mills savings between 2% and 6% of the total drying energy could be identified and realized. Additional benefit for the companies is provided by simulations of the energy consumption to be expected from machine rebuilds and using the simulation model for training of operators and other employees.