Possibilities for Energy Savings in the Drying Group

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Agenda

- Background and Motivation
- Drying Fundamentals
- Heat and Massbalance
- Case studies for energy optimisations
- Conclusion and Outlook

Background and Motivation

- Energy prices are increasing!
- Direct influence of energy savings in manufacturing costs
- 15 – 35 % of total manufacturing costs are energy costs
  - Depending on paper Grade (Source: Pöyry)
- 70 % of heat consumed in Drying section
- Detailed knowledge of drying process
- Knowledge of possibilities in energy savings

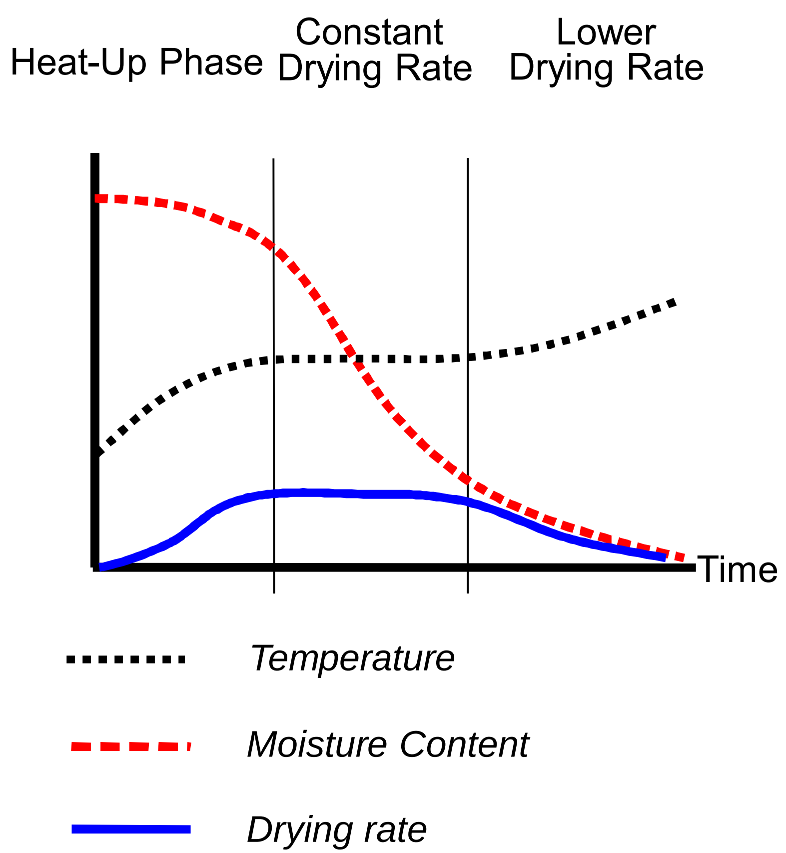
Background and Motivation

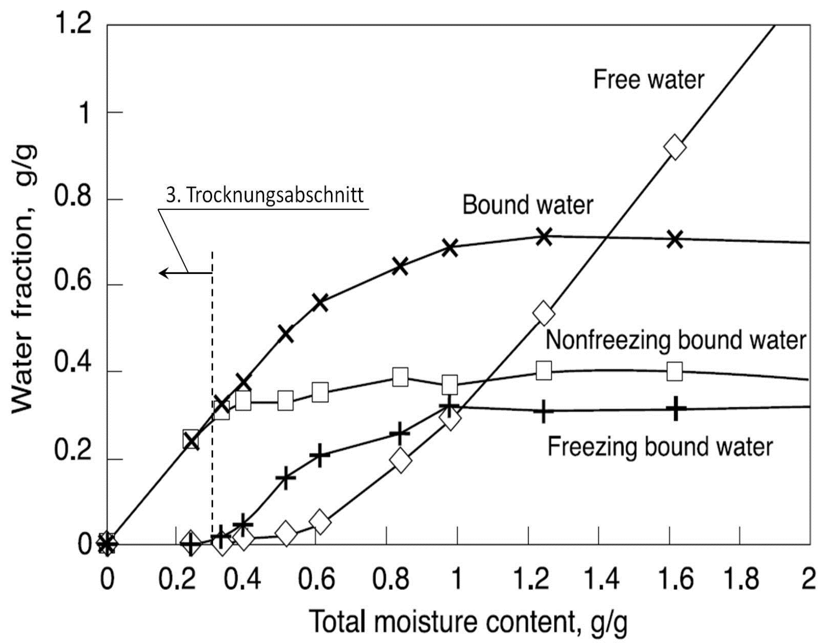
- Project was started in February 2011

- Physical simulation model for whole drying process incl. heat recovery, steam and condensate system

Save Energy!

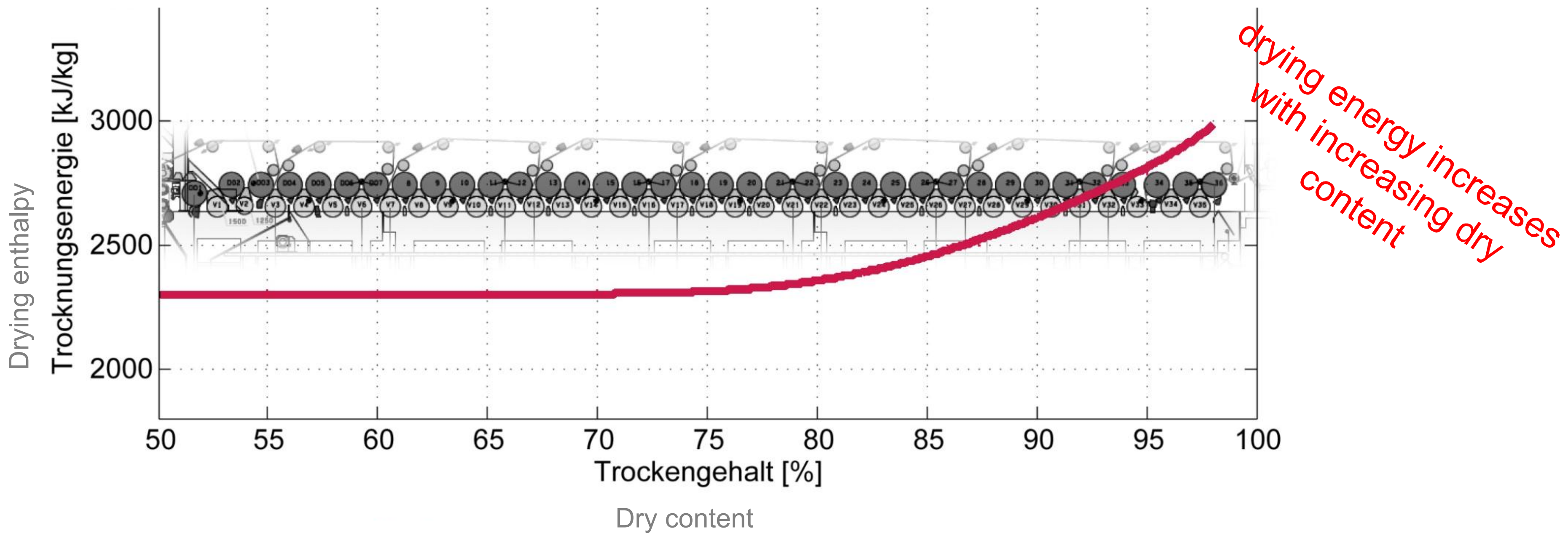
Drying Fundamentals





Drying Fundamentals

How much energy is necessary for drying paper?

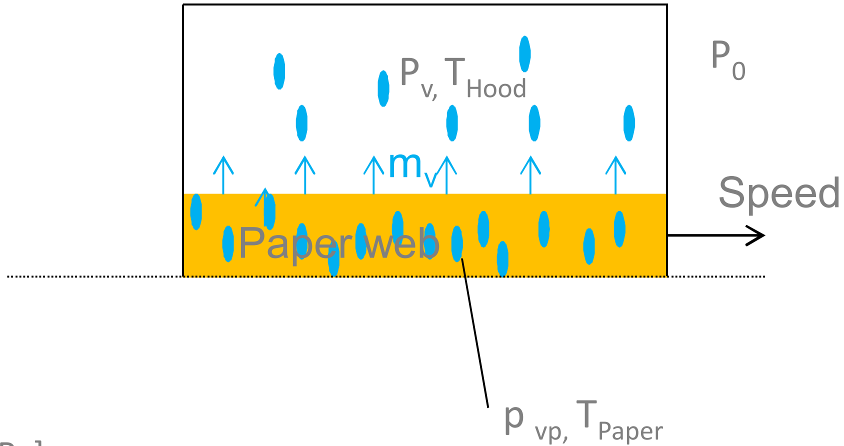


Source: Leuk, Methoden zur Bestimmung der Sorptionsenthalpie in der Papiertrocknung, Master Thesis, TU Graz, 2012

Drying Fundamentals

Evaporation of the web (Stefan Equation):

$$\dot{m}_{V.} = \frac{\beta * p_0}{T_{Paper} * R_v} \ln\left(\frac{p_0 - p_v}{p_0 - p_{vp}}\right) * A_{contact}$$



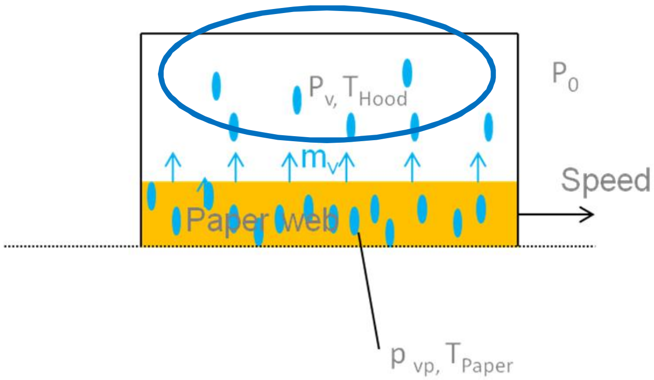
β	mass transfer coeff.[m/s]
m_V	evaporation rate [kg/s]
R_V	Gas constant vapour [kJ/kgK]
$A_{contact}$	paper surface area [m²]
P_0	total pressure [Pa]
p_v	vapour partial pressure of air [Pa]
p_{vp}	vapour partial pressure of the paper web [Pa]
T_{Paper}	temperature of paper web [K]

Drying Fundamentals

How to increase drying rate?

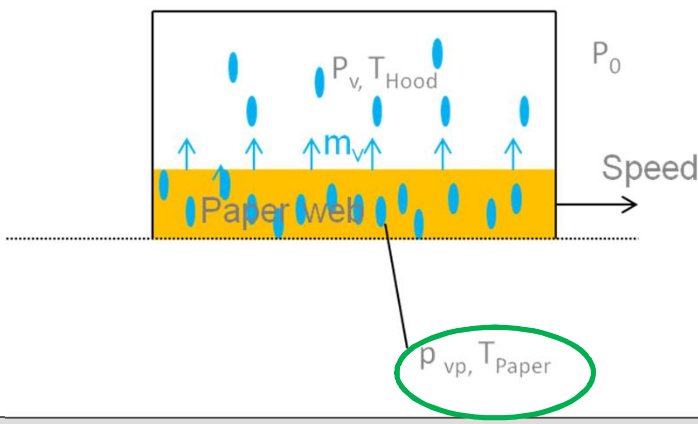
1.) Increase temperature of supply air

$$\dot{m}_{V.} = \frac{\beta * p_0}{T_{Paper} * R_v} \ln\left(\frac{p_0 - p_v}{p_0 - p_{vp}}\right) * A_{contact}$$



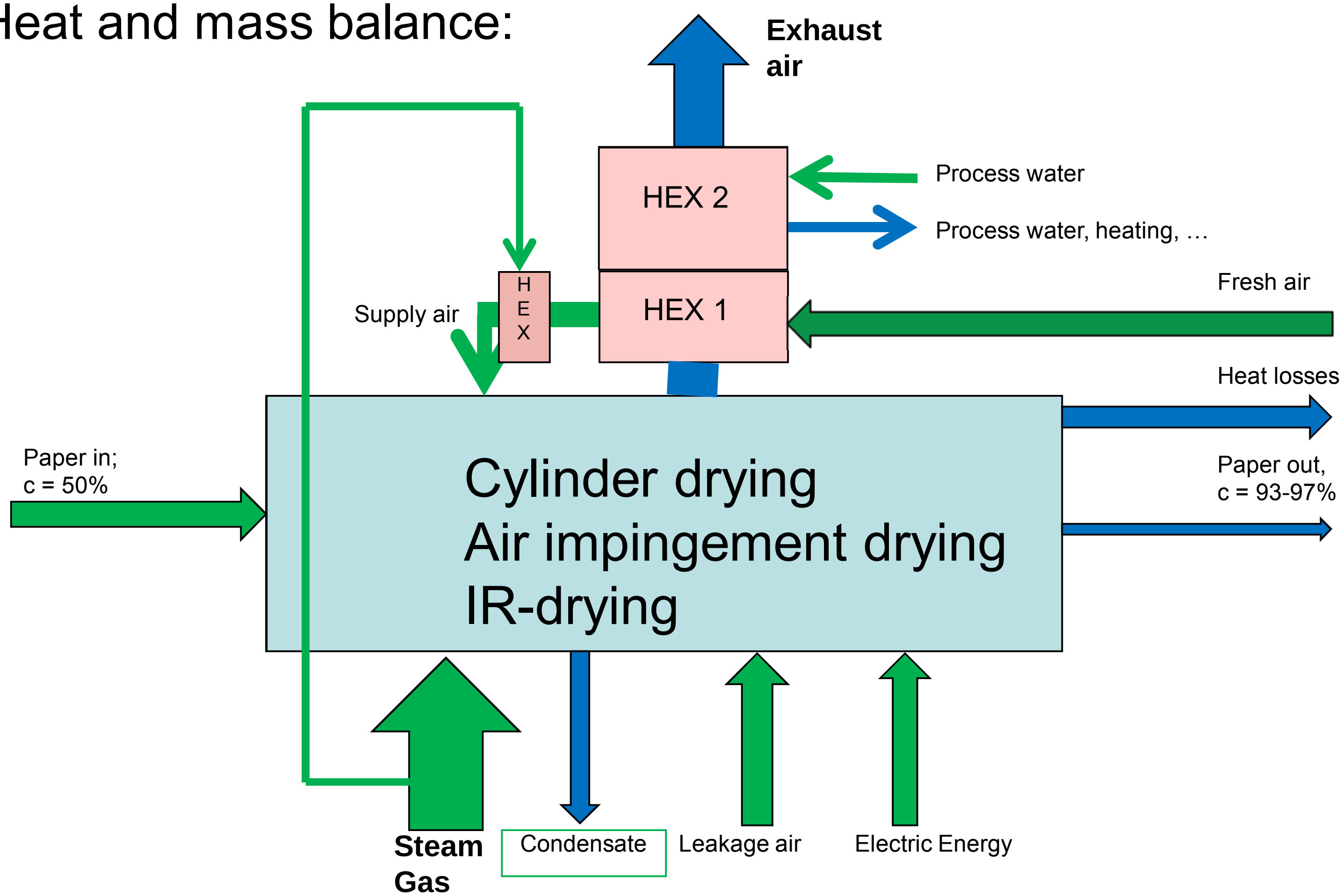
2.) Increase temperature of paper web

$$\dot{m}_{V.} = \frac{\beta * p_0}{T_{Paper} * R_v} \ln\left(\frac{p_0 - p_v}{p_0 - p_{vp}}\right) * A_{contact}$$



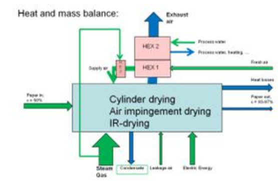
Heat and Massbalance

Heat and mass balance:

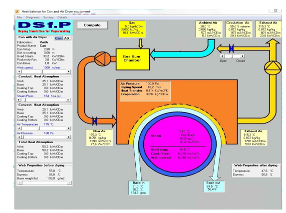


Heat and Massbalance

- Heat and mass balance for the drying group

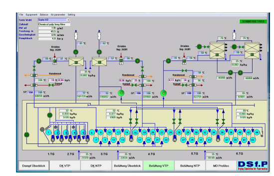


- Developement of a rough physical simulation modell
  - Drying group
  - Heat recovery system
  - Steam and condensate system



- Detailed measurements for different paper grades
  - Cyl. Temperature, Supply air, Exhaust air,…….

- Validation of the simulation model
  - Status: 2 models are ready; 2 models are in progress of validation



- Optimisation of the process in the simulation model

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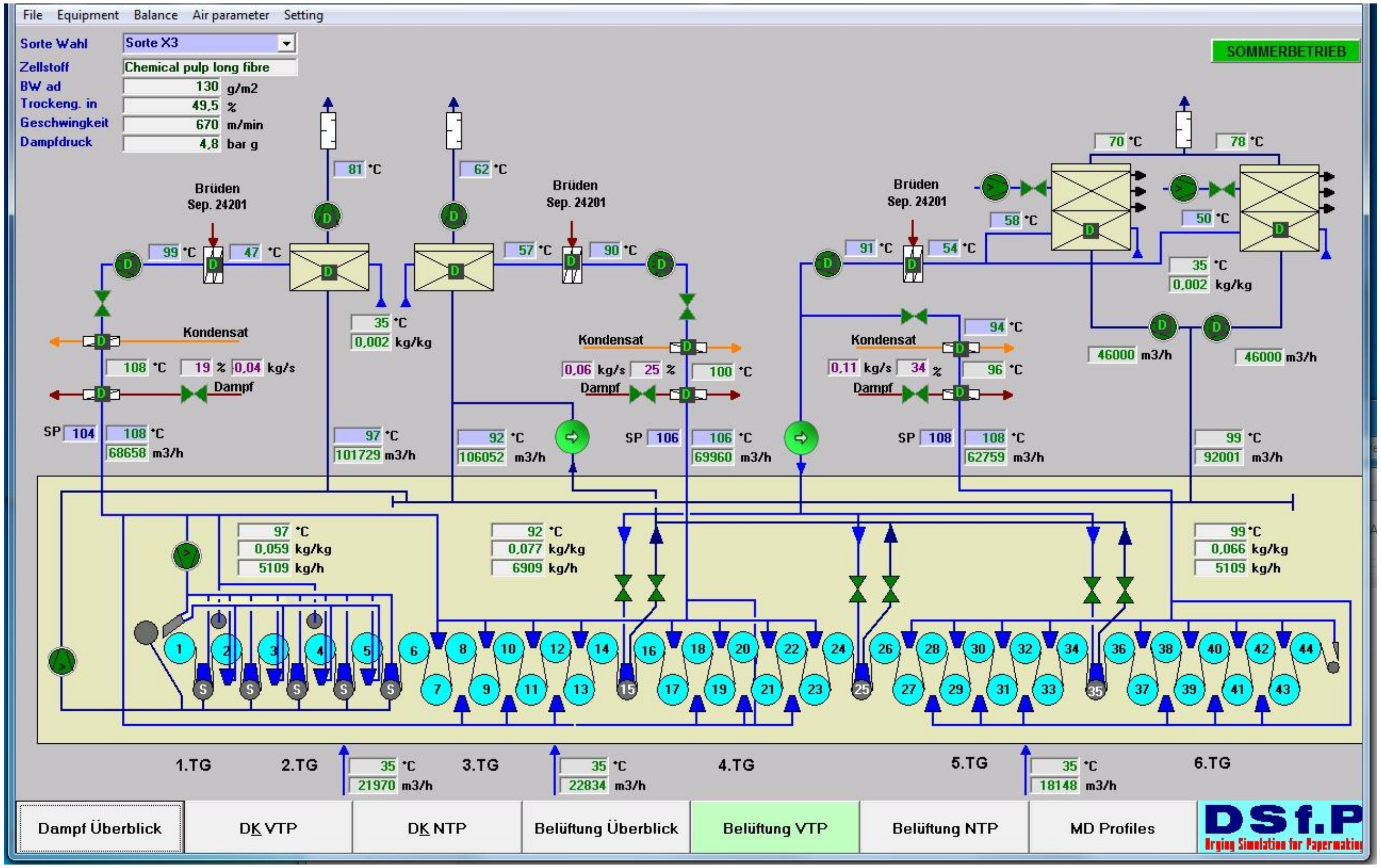
Heat and Massbalance

Example for a simulation model

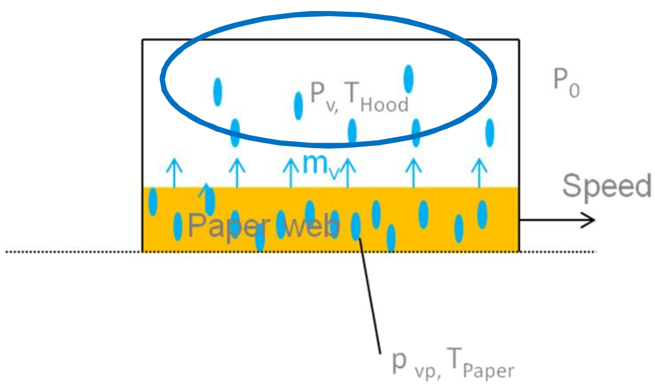


Case studies for energy optimisations

- Case Study # 1„Influence of primary energy suplly“

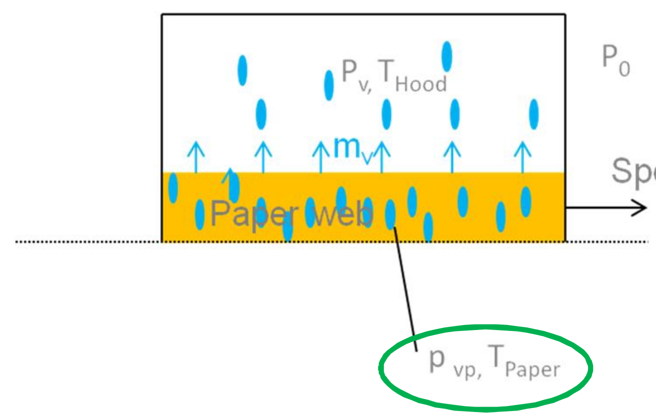
a.) increase of supply air temperature

$$\dot{m}_{V.} = \frac{\beta * p_0}{T_{Paper} * R_v} \ln(\frac{p_0 - p_v}{p_0 - p_{vp}}) * A_{contact}$$



b.) increase of steam pressure

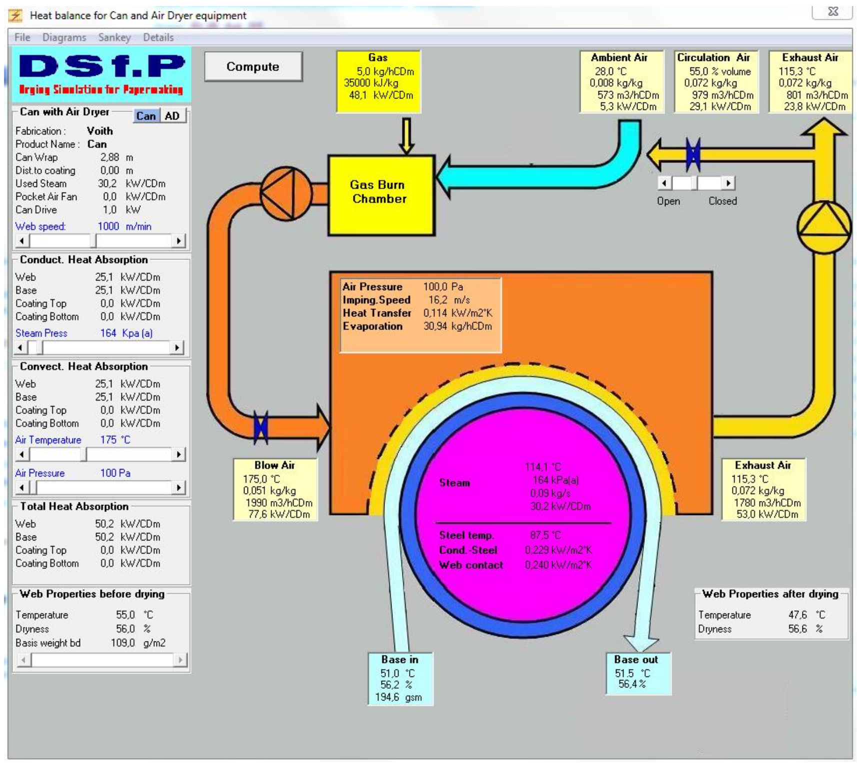
$$\dot{m}_{V.} = \frac{\beta * p_0}{T_{Paper} * R_v} \ln(\frac{p_0 - p_v}{p_0 - p_{vp}}) * A_{contact}$$

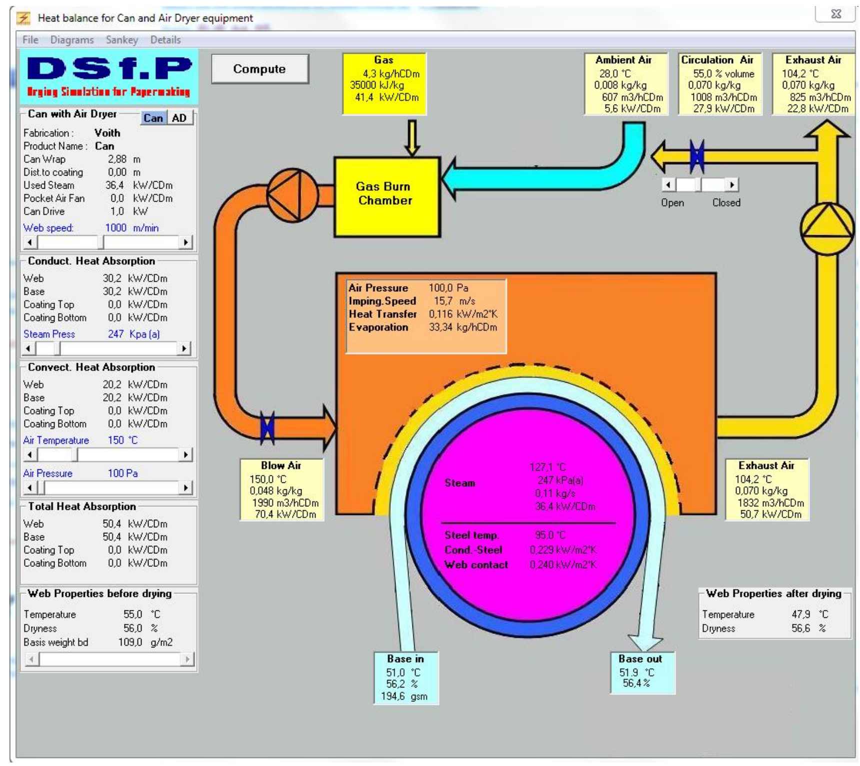


Case studies for energy optimisations

a.) increase of supply air temperature

b.) increase of steam pressure





$T_{supp\ air}$	= 175 °C
P_{steam}	= 1,65 bar
Heat adsorption of web	= 50,2 kW/CDm

$T_{supp\ air}$	= 150 °C
P_{steam}	= 2,47 bar
Heat adsorption of web	= 50,2 kW/CDm

Case studies for energy optimisations

General Acceptance: **EUR/kWh gas = 2.5 * EUR/kWh steam**

⇒ *Cost savings of 6% by replacing gas energy with steam energy.*

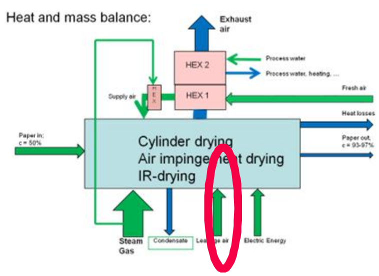
⇒ **Investment** *none*

Case studies for energy optimisations

Case Study # 2 „Influence of leakage air“

a.) actual situation:

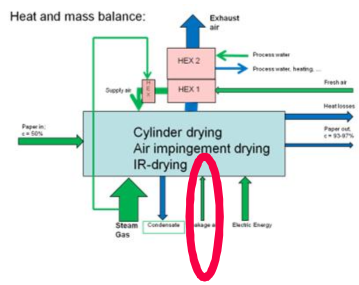
Supply air = 300.000 m³/h; $T_{supp\ air}$ = 90 °C; T_{hood} = 80°C;
Fresh air T = 10 °C, RH = 40%
Leakage air: T= 30 °C; RH = 50 %; **40% leakage air**



b.) optimisation of air balance

⇒ Reduction of **leakage air to 20 %**

⇒ Reduction of the flow from the exhaust air fans



⇒ *Energy Savings of 7.000 MWh_{th} / year*

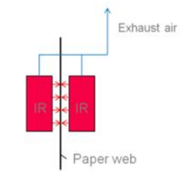
⇒ **Investment** *new belts and pulleys for fans*

Case studies for energy optimisations

Case Study # 3 Ă Use of exhaust air from IR-Dryers“

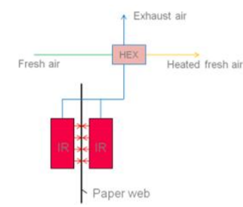
actual situation:

- exhaust air from IR- dryers not used in HR-System
- $\dot{m}$ = 10.000 m³/h; T = 165 °C



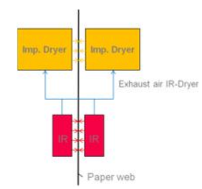
a.) usage in heat exchanger for fresh air heating

⇒ *Energy Savings of ~ 800 MWh_{th} / year*



b.) usage in impingement drying

⇒ *Energy Savings of ~ 3.500 MWh_{th} / year*



⇒ **Investment** *some piping and valves*

Conclusion and Outlook

- An accurate **heat and mass balance** is an old fashioned but highly effective toll for saving energy in the drying group.
- **Simulation Model** helps to see the impact of optimisations and minimizes risks.
- **Saving energy potential** in our case studies
  - Replace gas energy with steam energy
  - Minimize leakage air ammount
  - Usage of all exhaust air flows in the heat recovery system

Conclusion and Outlook

- Current **potential for energy savings of 2% to 5%** for the evaluated PMs
- Further machine trials are in progress – final results will be ready middle of 2013
- Project closure (and doctoral thesis!) until January 2014

Thank you for your attention!