TECHNISCHE UNIVERSITÄT DRESDEN

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Dry Defibration – a new pulping method as a prerequisite for novel paper & board production technologies

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DRESDEN concept

Background

- Improved energy and resource efficiencies as well as product innovations have to become the cornerstones of the future paper industry.
- Not for no reason, therefore, a main conclusion of CEPI´s Roadmap 2050 is that completely new, truly breakthrough technologies need to be developed, to reduce the energy consumption and thus the CO_2-emissions by 80 % compared to 1990.
- The energy intensity of the paper industry is to a very large extent a function of the amount of water used in papermaking process.
- In particular the thermal drying consumes most of the energy of the whole process chain which more or less directly translates into the generation of CO_2-emissions.
- Consequently, waterless paper production was among the most promising concepts identified in the frame of the so-called TwoTeam Project.

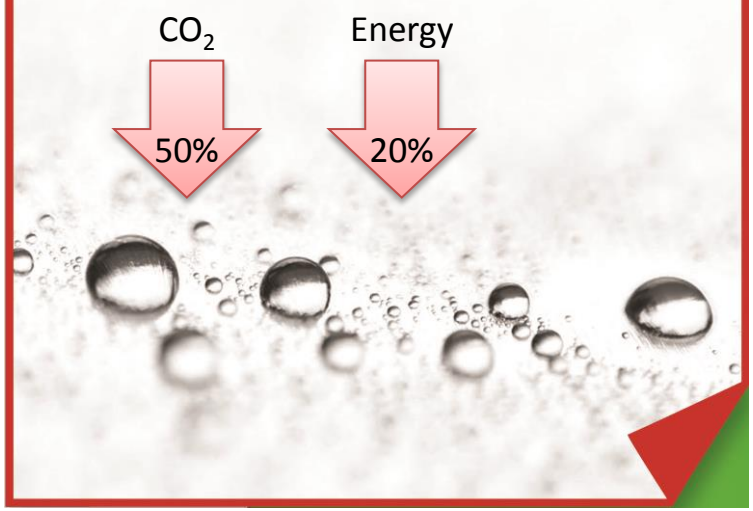
Background

The CEPI TWO TEAM PROJECT

Flash condensing with Steam

FINALIST

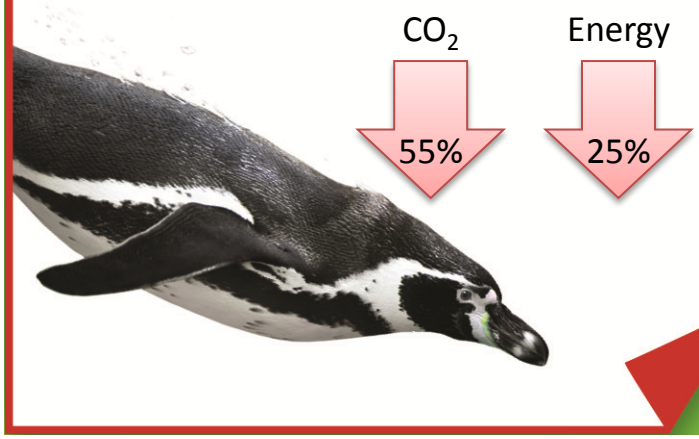
Waterless paper production?
Very nearly. Largely dry fibres would be blasted into a forming zone with agitated steam and condensed into a web using one-thousandth the volume of water used today.



DryPulp for cure-formed paper

FINALIST

Imagine a papermaking process that uses no water. This is it. Fibres are treated to protect them from shear, and then suspended in a viscous solution at up to 40% concentration. The solution is then pressed out and the thin sheet cured with a choice of additives to deliver the end-product required.



Initial Situation

- The objective of a research project called “Dry Defibration” was to examine in how far and for which qualities waterless processes are able to defibrate recovered paper in a more energy efficient way.
- It turned out that dry defibration has the capability to recover paper and board products with low or no recyclability at a far higher energy-efficiency than standard wet processes.
- Of course, also common grades of recovered paper can be defibrated sufficiently by dry defibration though with limited advantages in terms of energy efficiency and quality.
  - Dry defibration leads to fiber properties deviating from conventional pulps.
  - The advantages and disadvantages of dry defibration as well as suitable applications of dry-pulped materials will be explained in more detailed in this presentation for both conventional wet processes and novel dry processes.

Technology of Dry Defibration

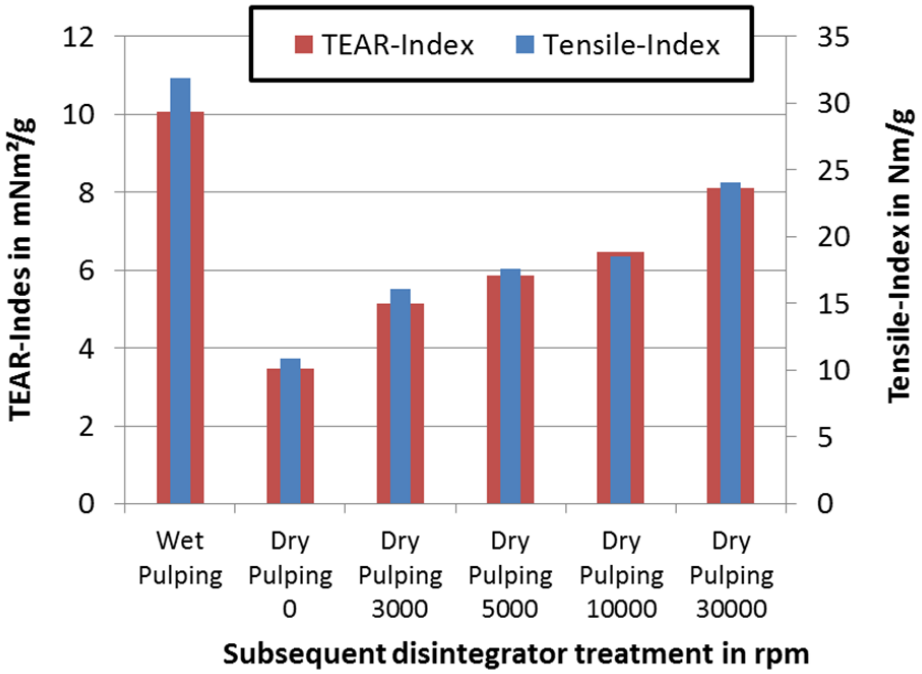
Technology of Dry Defibration

- The energy demand for the dry defibration highly depends upon
  - the properties of the product,
  - the acceptable flake content for the specific product,
  - the capacity of the dry defibrator and
  - the desired throughput.
- A specific energy demand of at least 75 kWh/t can be specified for dry defibration – which is far higher then that for standard wet pulping processes (10-40 kWh/t)
  - ➢ **valid only for paper products with low defibration resistance**
- **For difficult-to-recycle paper products, the energy situation turns upside down:**

  SEC for **wet defibration** can easily **rise to 300 kWh/t** and even more because of
  - ➢ a 10 times longer dwell time in the conventional pulper,
  - ➢ the need for subsequent deflakers or refiners,
  - ➢ additional steam utilization for hot disintegration and
  - ➢ through the use of chemical additives.

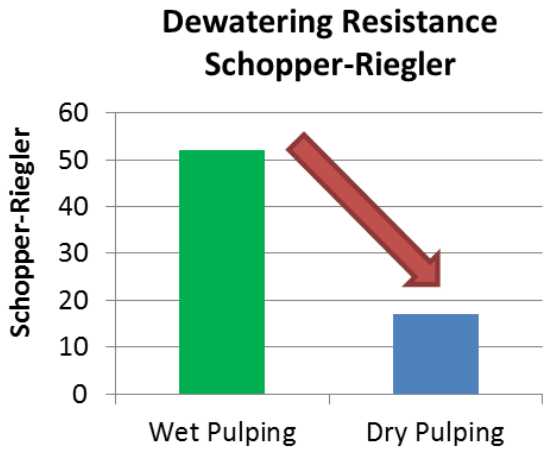
Effects and Potential of Dry Defibration

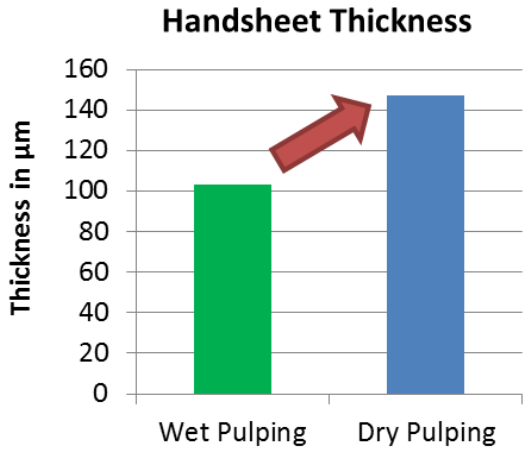
- Due to several accompanying effects dry defibration initially leads to an inactive fiber with limited strength potential.
- Characteristic accompanying effects are a decreasing fibrillation and fiber flexibility as well as fiber shortening.
- However, occurring fiber anomalies which results in reduced sheet strengths can be compensated by appropriate fiber reactivation measures.
- In addition, the remaining gap to the wet pulping reference can be closed by more adjusted and gentle dry defibration conditions.



Effects and Potential of Dry Defibration

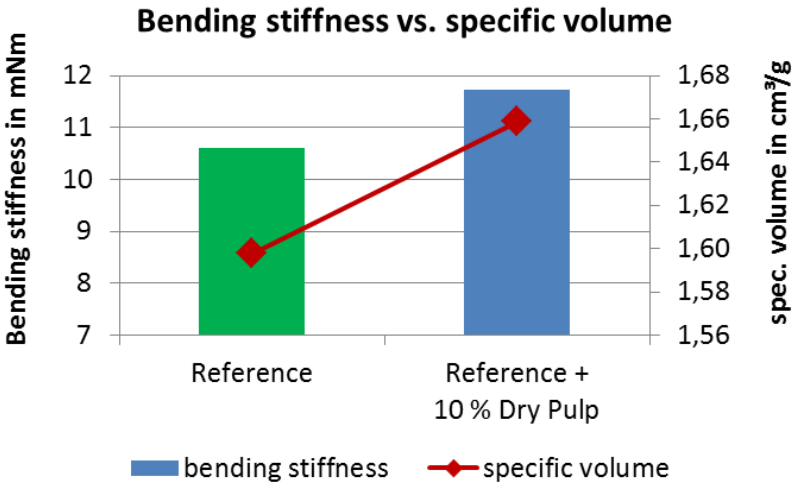
- However, the effects shown need not necessarily to have a negative impact.
- Properly dosed and used, the characteristic properties of dry-pulped materials have the potential for improving the conventional manufacturing process as well as the sheet properties of selected paper and board products.
- Compared to wet pulped material the use of dry-pulped fibres enables an essentially faster dewatering and, furthermore, results in significantly higher sheet thicknesses.





Effects and Potential of Dry Defibration

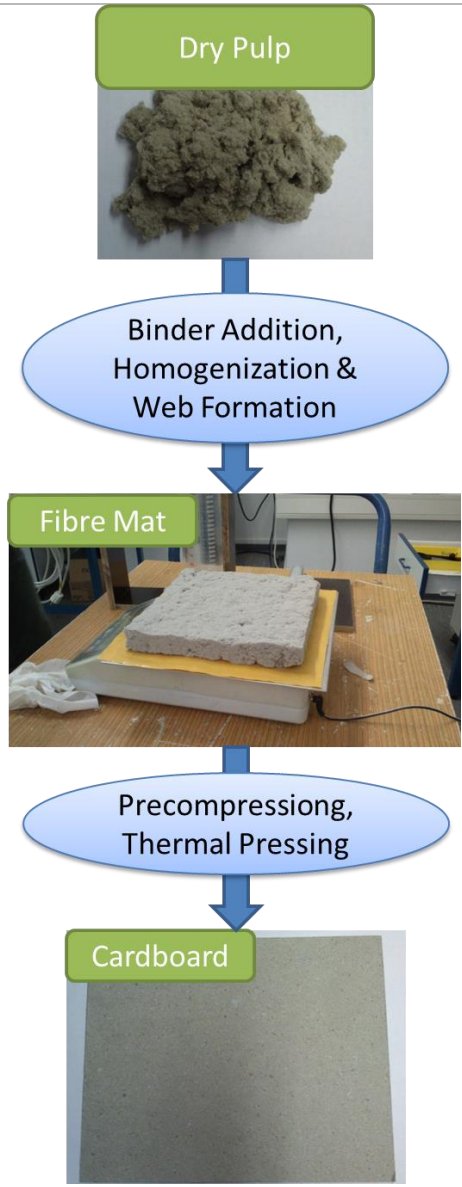
- Laboratory trials have shown that the controlled use of dry-pulped materials and their characteristic properties allows an improvement in the specific volume and bending stiffness.
- Especially the potential for increasing the specific volume is conform to the development targets of specialty paper and board manufacturers.
- The much faster dewatering speed of dry-pulped materials could also increase the productivity by higher machine speeds or increased basis weights.



- Reduced drying costs due to a higher dry matter content after the press section are also possible.

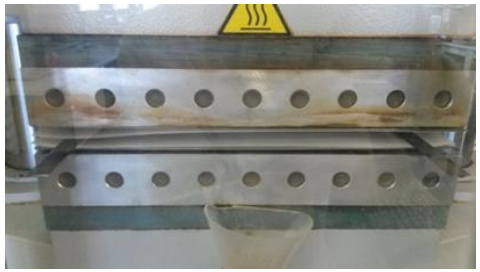
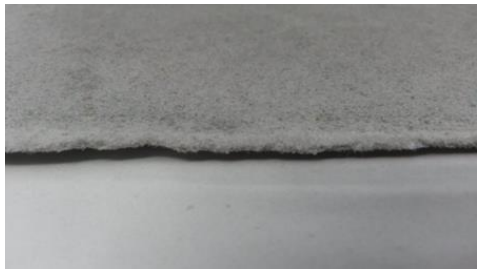
Dry Cardboard Production

- A simple model for a dry papermaking process could be the fibreboard production where the original wet process was almost completely replaced by a more environmentally friendly dry process.
- Main driving forces for this shift were
  - waste water problems and high drying cost
  - ➢ ecologic and economic factors.
- Besides dry defibration, key elements of such a process chain are
  - Binder addition and mixing
  - Web formation
  - Thermal pressing.



Dry Cardboard Production

- Due to reduced water content (max. 33 % MC), a subsequent conventional drying is dispensable, but binder activation and web compaction is required.

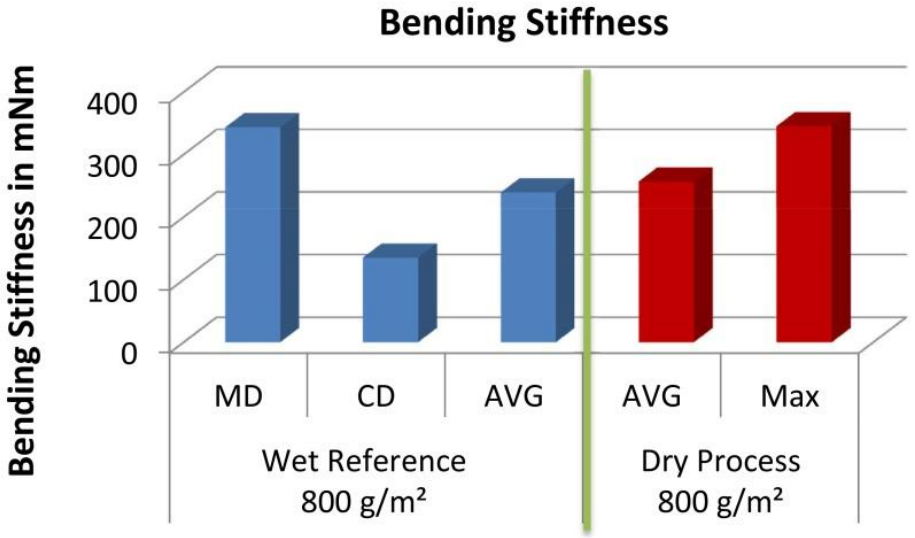
- Such a continuous dry manufacturing process would
  - result in substantial savings in energy and water
  - contribute to the improved environmental performance
  - require significantly lower investment costs
    - ➢ No vacuum system in the wet-end
    - ➢ No traditional drying section
    - ➢ No traditional water circuits and waste water treatment
  - allow to produce heavy-weight multilayer boards at far less efforts for dewatering and drying.

Dry Cardboard Production

- Initial investigations in laboratory and pilot plant scale gave evidence that cardboards can in principle be manufactured in a dry process without sacrificing neither quality nor competitiveness.

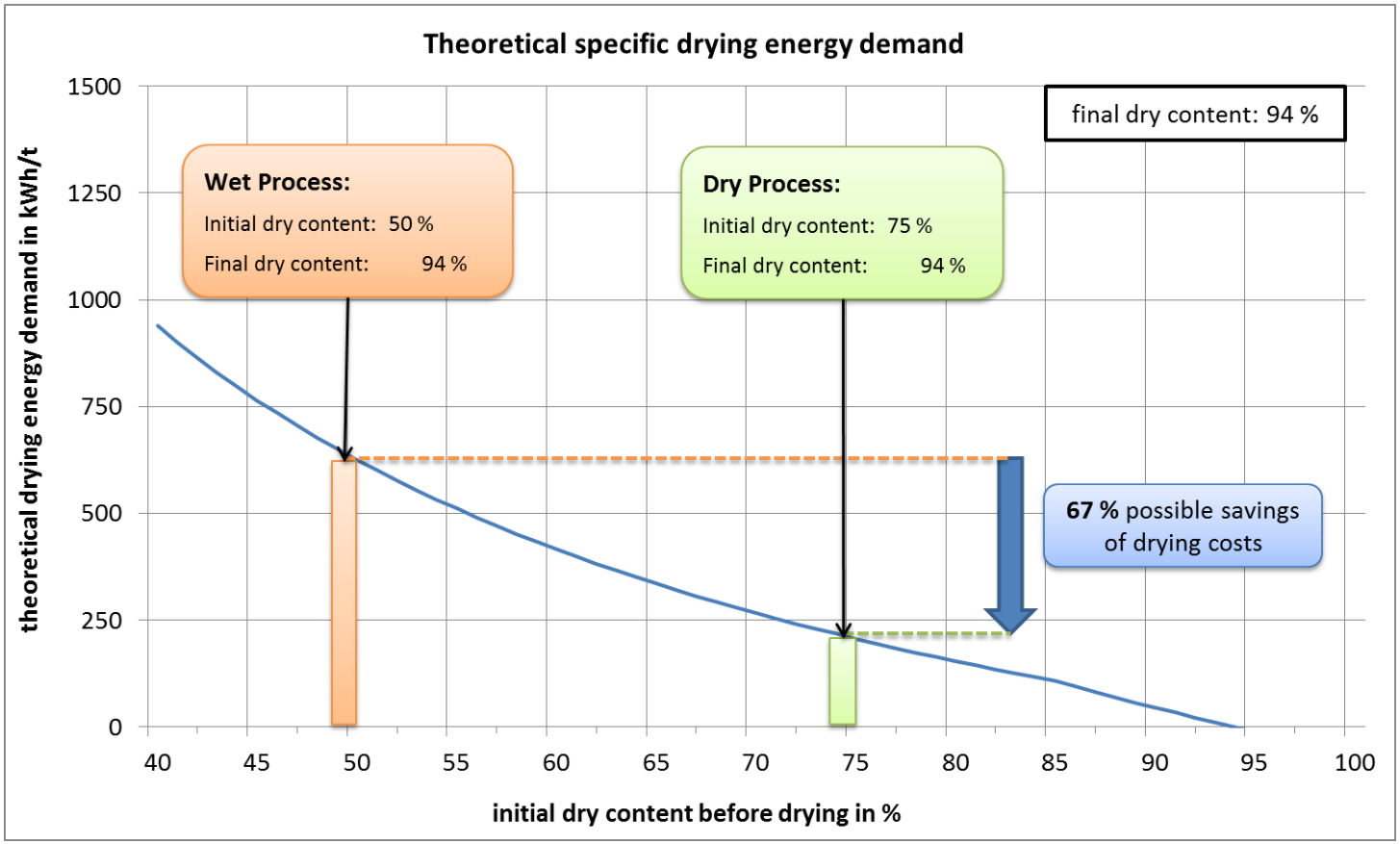
- Of particular importance is the fact that the strength properties obtained are comparable to those of conventionally produced cardboards.

- The value for bending stiffness of dry-formed cardboard is far above the bending stiffness of conventional cardboard in cross direction (CD) and even higher than the average from machine and cross direction (AVG).



Comparison of bending stiffness between conventional and dry produced cardboard

Dry Cardboard Production



Calculation of possible savings through a reduced drying energy demand

Dry Cardboard Production

- The major drawback of this method, however, is the necessity to add a binder as hydrogen bridges between fibres cannot develop in the absence of water.
- Although there are a number of binders which are potentially suitable for this purpose, their costs in the end might eat up a significant part of the savings achieved.
- The feasibility of the idea of dry board manufacturing therefore hinges strongly on the availability of a suitable and affordable binder which should not only meet technical and economical requirements (applicability, costs and dosage), but also ensure all qualitative targets of the final product and its recyclability.
- Another disadvantage are the limitations in drying speed when a continuous press is used.
- This limitation negatively affects the economic efficiency and is the reason why such a dry process is currently most probably only suited for cardboards which allow a production at moderate to low machine speeds like e. g. very heavy or high-end products and some special grades.

Summary and Outlook

- The dry defibration process concept presented here has the capability to recycle difficult to recycle paper products at a far higher energy-efficiency than standard wet processes.
- Furthermore, a controlled use of the characteristic properties of dry-pulped materials can be beneficial for selected applications in the conventional manufacturing process.
- It turned out that both quality and economics of selected products can be significantly improved as compared to a purely wet process.
- Results obtained in comprehensive laboratory studies on the concept of dry cardboard production presented here, gave convincing evidence of the feasibility of these technique at least as far as laboratory scale is concerned.
- This applies especially to packaging paper and board products with low quality requirements.
- In view of these promising results, the investigations should be continued in both research fields.

Thank you very much for your attention!

» Science creates bridges. «

Don’t hesitate contacting us for further information

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