MEDIA DRYING ON A HIGH SPEED WEB PRESS

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Objective

Find a combination of conductive, convective, and radiative heat transport combined with convective mass transport to effectively dry a high speed web press while avoiding over-drying.

Background

High speed HP printing presses feature a continuous web of paper running at hundreds of feet per minute.

This process requires active drying of the ink using combinations of impinging jets and infrared lamps. Drying rates must increase as print speeds increase, but faster drying causes problems with paper quality.

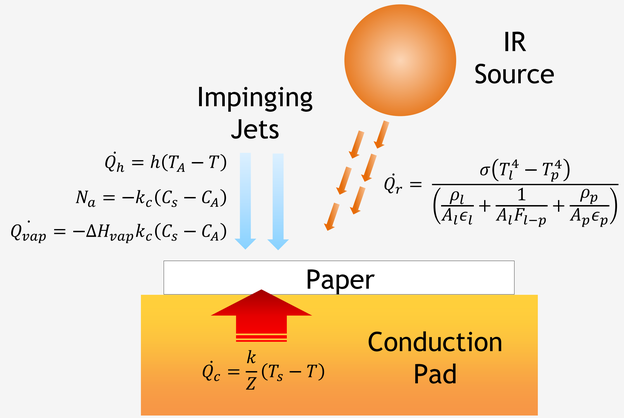
- Paper has a natural moisture equilibrium with its environment
- Moisture changes cause cellulose fibers to expand or contract
- Varying ink density (e.g. text, pictures, or white space) creates moisture gradients
- All of the paper web receives the same drying, so areas with ink densities lower than the max are generally over-dried

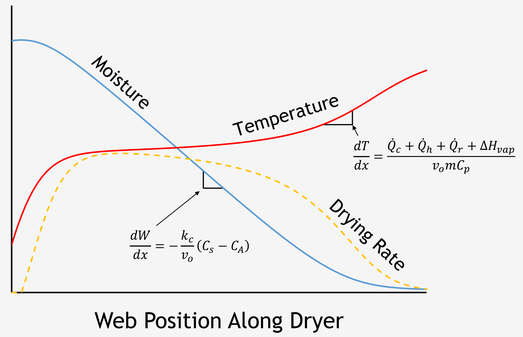
All sections of the paper experience expansion and contraction. Furthermore, the paper is sometimes is put through finishing equipment and bound into books before it is able to equalize with its environment.

T-400 HP Webpress

Theoretical Transport Model

- Convective mass transfer
- Radiative, conductive and convective heat transfer





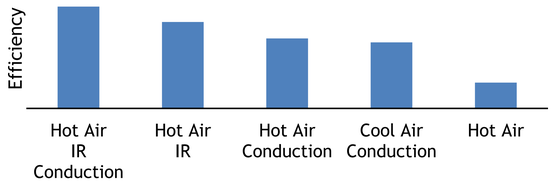
Energy goes into sensible heat until the temperature reaches some optimal level, where energy goes into the latent heat. In order to sustain this drying rate, energy must be supplied to the paper or else the temperature will drop back down alongside the drying rate.

Energy Efficiency

Energy Efficiency was defined as the fraction of energy that the dryer consumed that went into evaporation.

$$\eta = \frac{L\, v_o\, \Delta H_{vap}(\rho_f - \rho_o)}{P_{input}}$$

The moisture difference before and after drying can be used with the paper speed to determine how much energy went into evaporation. The power consumption of the dryer was a measured and known value.



The energy efficiency was highest when all three types of drying were used. Adding Conduction to Hot Air and IR didn't increase the efficiency that much, but the printing speed doubled.

Acknowledgements

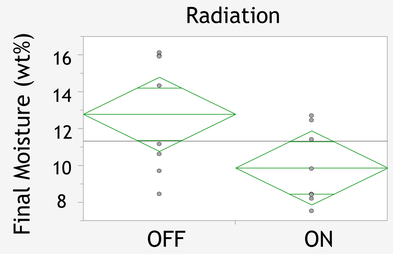
- Ron Anderson for experimental design and assistance
- Jason Hower for conceptual feedback
- Jim Kearns for sponsorship of the project
- Dr. Phil Harding for project guidance

Conclusions and Future Work

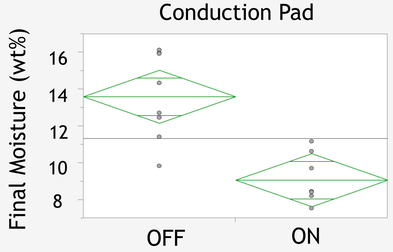
- Paper quality is not improved with these methods
- Energy efficiency is mostly affected by maximizing the time spent at the optimal drying temperature
- Maintaining the peak drying rate requires a heating source, and maintaining the peak drying rate allows for faster printing
- Heating source doesn't have to be IR

Statistical Analysis

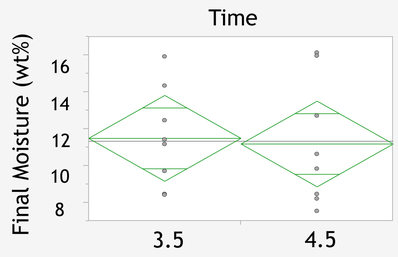
One way ANOVAs were performed on four factors. The diamonds represent 95% confidence intervals.



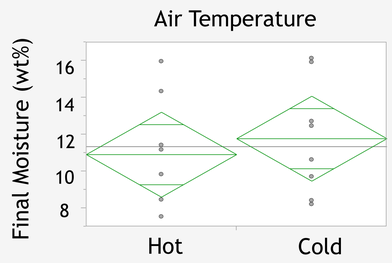
Radiation showed a marginally significant effect on the final moisture content.



Conduction pad showed the most significant effect on the final moisture content.



Time showed no effect on the final moisture content.



Air temperature showed an insignificant effect on the final moisture content.