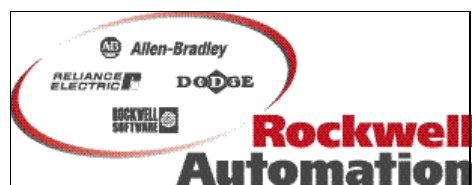


The Faster, Better Paper Machine

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Answers to Questions – Drives/Process Control

Are current drives capable of running at surface speeds of > 12,000 feet per minute on a paper machine?

Paper machine (PM) winders have far more demanding performance requirements than a paper machine. This includes rapid acceleration and deceleration rates, very accurate tension control, and far more sophisticated torque distribution strategies. PM Winders are already operating at paper surface speeds approaching 10,000 feet per minute. Motors, power units, or control strategies should not prevent paper machine speeds from reaching this speed.

Can current drives be controlled at those speeds to provide proper tension to the sheet?

Again, more accurate control of tension than is required for paper making is already being achieved at the PM winder, and this is under more demanding operating criteria such as acceleration, deceleration, and transitions from and to zero speed.

In all likelihood, physical limitations of dancers (or float rolls) will preclude their use for tension control at high speeds as their variable dynamics will be more problematic at these speeds. Therefore, reliance on already developed sound, closed-loop tension control strategies employing tension transducers will be a must at the dry-end of the machine.

Open-loop draw control will still be the requirement at the wet-end of the machine.

Implementation of outer surface-speed control loops will likely be required for sections with fabrics. [See question 10 below]

What control strategies or innovations will be needed to upgrade current drives to high-speed standards?

Actually there are potential benefits to increasing paper machine surface speeds relative to drive systems. In a paper machine, the driven rolls that process and transport the sheet are relatively large in diameter. Therefore, higher surface speeds will reduce the degree of, and in many cases eliminate the need for, speed reduction components in the drive train.

This situation will reduce the difficulties associated with drive train power losses as well as the variable dynamics associated with multiple shafts and couplings. In other words, simpler, more straight forward in-drive systems are a major advantage for drive-system performance as line speed increases.

Will new control standards be needed if paper machine speeds double, or can current systems be upgraded?

Standards are always evolving relative to new technologies, and significantly higher speeds will likely effect changes in control standards. Normally, "upgrading" a system is associated with a maximum 25 percent performance improvement. Upgrading isn't probable to achieve a doubling of performance.

Increases in speed certainly will require increases in connected sectional drive power. AC drives will be more attractive at higher speeds, and in-drive mechanical components will require significant improvement.

If desired control is 1 FPM accuracy between drives, that is 1/10,000 accuracy. Is that feasible for current drives as we know them?

This statement or question is a common misunderstanding. The actual draw parameter in a moving sheet, which effects tension, is actually a ratio or percentage phenomenon and not an absolute difference phenomenon.

The reason for the confusion is that paper makers, who normally relate to a specific machine, operating within a relatively narrow window of surface speeds, use absolute FPM differences in speed for their judgment as to appropriate section-to-section draws. As well, drive system suppliers, in order to satisfy this method of judgment for a particular application, provide speed / draw indicating systems that display draw in absolute FPM difference. Both contribute to the misunderstanding.

Properly configured draw control systems actually control speed ratios that are more correctly dimensioned in ratios and/or percentages. As such, the ability to effect the control of required percentage draw accuracy as paper machine speeds increase should not be a problem. Displaying them effectively for the paper maker, in formats they are accustomed to, may be.

Will increased speed mean going to AC or DC?

Certainly, as stated above, AC drives will be much more attractive if significant increases in paper machine surface speeds are realized. The reasons are:

AC motors, due to their mechanically reliable rotors, are more compatible with higher motor speeds, which will be required for the rolls in the machine with smaller diameters.

Higher surface speed machines will likely result in wider operating speed ranges. This situation will make the unity power factor characteristic of the AC drive very attractive.

Achievable torque and subsequent speed control loop bandwidths are significantly higher for pulse-width-modulated variable-frequency AC drives compared to DC drives. This will be a major consideration as surface speeds increase significantly.

Will limitations on the drives be mechanical or technical?

The more difficult hurdles will be mechanical. Drive motors are already operating at motor speeds far below existing limits or are having their speed significantly reduced mechanically.

The greatest problems will be dynamic issues (such as natural frequencies, mechanical dead-bands, and compliance in the drive-train) relative to shafts, couplings, and process and transport rolls.

What will be the effect on the forming fabric and dryer felts of operating drives at higher speeds?

Relative to the fabrics, this question is probably best answered by a paper machine fabric expert. Relative to the drive and its responsibility to control the sheet speed, as well as the driven equipment speed, the most obvious potential problem at significantly higher surface speeds, would be roll-surface-to-fabric-surface slippage, causing poor sheet-speed regulation.

Relative to this issue, and questions number 2 & 3, to achieve good sheet-speed control, outer surface speed control loops may have to be incorporated, utilizing new surface speed transducer technologies such as lasers.

How will maintenance of drives be affected at higher operational speeds?

There is reason to believe that drive maintenance may be reduced due to the above-referenced expected reduction in complexity of the in-drive components.

Over the past decade, drive products and systems manufacturers have positioned themselves well by incorporating high-speed diagnostics into drive and system products for analysis of both the drive products and the driven processes.

Significant increases in paper machine speeds, which as stated above is principally an increase in process speed and not necessarily an increase in drive motor speeds, will begin to rely more on the driven equipment, process diagnostics, and maintenance support features of the drives and drive systems.

Answers to Questions - Winders

Are winders a critical limit to machine speeds? Since winders must be faster than the machine, can current designs be upgraded, or will new designs be needed?

Increasing the maximum surface speeds for multiple-set PM winders eventually realizes the law of diminishing returns. The limiting factors of multiple-set winders being able to keep up with the increasing speeds of paper machine production are set change times and acceleration and deceleration rates.

Today, unique high-performance PM winder configurations such as single-drum and surface/center wind systems already require multiple winders per machine due to their set change limitations. Therefore, having a greater-than-one ratio between winders and paper machines will not be new.

Are current tension controls and sensors adequate for winding at 12,000 FPM?

Per answer to question number 1 above, maximum winder surface speeds may not be able to be increased significantly greater than the existing 10,000 FPM.

Tension transducing components such as rolls, bearings, and transducers need to be dynamically suitable for the *application*. With higher-speed machines, even greater attention must be paid to choosing components with the proper natural frequencies.

What must change in the re-winder and slitter operations to handle a paper machine putting out twice as much paper per day?

See question number 1 above.

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