

THE PAPER MACHINE OF TOMORROW—MAINTENANCE AND ENGINEERING

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EXPERTS ON PAPER MACHINE MAINTENANCE AND ENGINEERING DISCUSS CONDITIONS AND OBSTACLES ASSOCIATED WITH DOUBLING THE SPEED OF THE PAPER MACHINE

THIS ARTICLE, THE EIGHTH IN *TAPPI JOURNAL*'s Technology Spotlight series, focuses on the maintenance and engineering limitations the industry faces with the "paper machine of the future"—the machine developed to run at 10,000 to 12,000 ft/min.

Industry experts who responded to the questions include Matti Lopponen, pulp and paper industry specialist, Lincoln Industrial; Juha Ehrola, general manager—technology, Valmet; Don Mahan, staff manager—paper and finishing, and Romain Slabbaert, manager—forest products, Houston operations, both of Brown & Root.

TAPPI JOURNAL: *What are the limits of the paper machine at high speeds? Bearing failure? Dynamic instability? Synchronization?*

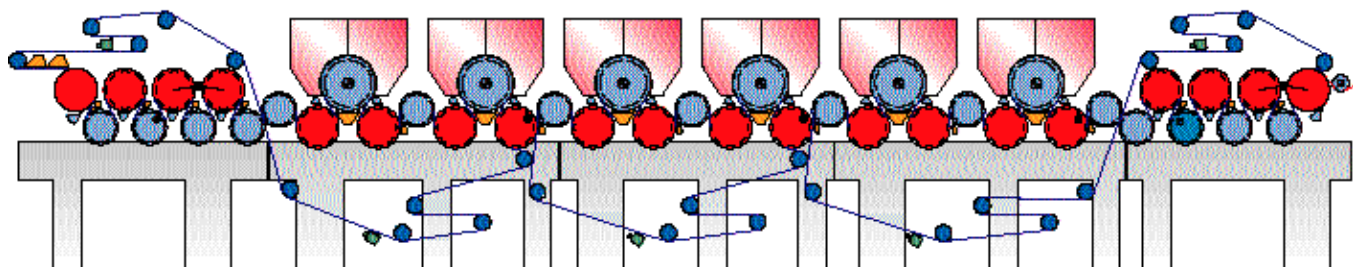
Lincoln Industrial: Bearings (bearing failures) are not a limitation at high speeds. In fact, lubrication theory supports this since speed improves lubricant film thickness. Bearings themselves have improved. There are also new designs coming to the market specifically engineered for the paper

industry's use. Other positive issues that make bearings less critical: lubricants and filtration have improved considerably, bearings seals are better. Practically all bearings in modern machines are lubricated by oil (circulating lube oil).

Of course, bearings can fail because of other reasons than lubrication. However, historically, lubrication-related issues are the biggest share of the pie.

Valmet: Higher speeds pose many challenges for a paper machine. The sheet is more difficult to form, and great quantities of water must be removed quickly. However, when dimensioned correctly, many parts of the paper machine could mechanically run even double the current speeds. On the other hand, there are positions where changes would be needed—for example, the headbox would require pressures four times greater if speed was doubled.

Brown & Root: Dynamic instability (breaks and sheet crushing) will limit machine speed when trying to run uncoated free sheets at 10,000 ft/min.



Concept paper machine (courtesy of Valmet Corp.)



One machine winder will not be able to keep up with the machine unless major improvements are also made in machine winder performance. Winders may replace the reel, run continuously, and deliver rolls instead of jumbo reels of paper.

TJ: *Are there different maintainability-related design paradigms for paper machines that companies should consider when planning for future paper machines? How can future machines be designed to improve maintainability?*

Lincoln Industrial: Although most bearings in modern machines are all oil lubricated, a machine has hundreds of grease-lubricated points, such as hinge points, slides, bushings, etc. Lubrication of these points can be very important to ensure proper machine operation. For example, increased friction due to improper lubrication of slice or press loading mechanisms can lead to poor CD control. Another example affecting paper quality could be doctor blade hinge points and supercalender slides.

Manual lubrication of some of these points while the machine is running is impossible. Because of the above reasons, leading paper machine OEMs have started to automate the grease lubrication of the most critical grease points.

Valmet: Mills need to decide how much of their own maintenance they will do and how much will be outsourced. This will dictate the mix of skills needed in house and how much technology should be included with the machine.

Maintenance issues should be considered from the start when a new machine is considered. For example, roll change times can be significantly reduced if the machine is designed that way from the beginning. New machines also can be designed with integrated machine and process diagnostics and trouble shooting systems.



Photos courtesy of Lincoln Industrial

Brown & Root: With the advent of increased speeds and wider machines, the machine frames and foundations to support these machines will influence the accessibility for machine maintenance both in the basement and on the operating floor levels.

Machines could have complete assembled roll magazines to facilitate roll changes and reduce downtime—for example, rolls could be installed in carousels, which would provide quick roll changes.

New & better roll cover material would have to be developed, and more machine mechanical diagnostic sensors must be installed.

TJ: *What are the limits on the width of a paper machine?*

Valmet: Increasing the width beyond 10 meters increases the investment cost more than it increases the production. The wider the machines, the heavier the rolls, and wide, heavy rolls are difficult to handle.

Width does not necessarily cause vibration, but speed does. Width, however, makes the vibration consequences more severe as the vibrating mass is larger and the amplitudes greater.

Brown & Root: Roll metallurgy, foundation supports, and machine frames.

TJ: *Will the sheet itself have to change in papermaking? Will thinner sheets cause maintenance problems? Will added filler cause more abrasion?*

Valmet: With thinner sheets and the use of more filler, achieving good runnability at high speeds will be more



Photo courtesy of Lincoln Industrial

challenging. High filler content can also cause more wear on running parts.

Brown & Root: The raw materials will stay the same, since it (wood pulp) is relatively inexpensive, but, at some point, the fundamental method of putting the sheet together at the wet end must change.

Removing the tremendous quantities of water from the fiber with current technology is not very cost effective.

Sheets will probably be made with increased filler content to reduce costs, but sheet caliper will not be reduced in order to maintain sheet stiffness and opacity.

Increased filler will not cause more abrasion, but the increased speed will increase it exponentially.

TJ: Will “closing” the paper mill cause maintenance problems for a high-speed machine?

Valmet: “Closing” can create chemical and biological complexity, dirt, and contaminant accumulation. This leads to all kinds of process problems as well as malfunctions, especially in instrumentation. When the mill water system is closed, the chemical stability of the white water and stock system is more difficult to handle. Also, corrosion becomes an issue.

Brown & Root: “Closing” the paper machine means reducing overall water usage, and this requires additional equipment (filters, strainers, cooling towers, pumps, and controls). Additional maintenance for this equipment is required.

“Closing” the system generally increases corrosion and causes increased deposits. Proper selection of metallurgy and proper design of systems can negate most adverse effects.

TJ: What are the issues of supplying a paper machine running at 10,000-12,000 ft/min with stock? Will multiple fan pumps be sufficient if stock demands are doubled? Can these be maintained?

Valmet: Multiple pumps should be able to accomplish this. However, it makes the system more complex and, possibly, difficult to control. The primary effect on maintenance would be a greater amount of machinery to maintain.

Brown & Root: Supplying stock to a paper machine at double current rates will not present any show stoppers. Larger pumps, cleaners, deaerators, and screens would be required.

The big problem is not getting the stock (fiber and water) to the machine, but in separating the fiber and white water on the sheet former and in the press section at high speeds.

TJ: Will current white water systems be able to process water at double the current rate? Will closing the mill affect this? If so, how?

Valmet: Pumps, valves, and pipelines would have to be larger which would entail a major rebuild of existing machines. Most probably the consistency in the headbox would also have to increase.

Brown & Root: Current white water systems could process water at double the current rate with larger equipment. But I don’t think the paper machines will be able to handle the volumes. We will probably see higher headbox consistencies as machine speeds increase. This has been the trend for the past 25 years.

Closing up the system is another separate issue which involves water availability and environmental issues.

TJ: *Are current wires useable at double current machine speeds? What wire guidance problems could occur at 10,000-12,000 ft/min?*

Valmet: Most current wires probably could not contend with double machine speeds. However, fabric development tends to keep pace with machine development. Much higher wire tensions would be needed, which could be a problem. Non-contacting guiding systems are definitely needed at these speeds.

TJ: *Will current couch roll technology work at these speeds? Can the rolls drive the wires at these speeds, or will direct wire drive be necessary?*

Valmet: At very high speeds, stationary vacuum boxes would be needed. Perhaps more driven rolls would also be needed. It is questionable whether today's shell materials could handle double speeds.

Brown & Root: Couch rolls cannot stand to be much wider with current metallurgy and hole configuration. That also goes for suction rolls. We will have to start providing mid machine support to prevent the rolls shell and box sagging phenomenon, which results in suction couch rolls failing at mid point.

TJ: *What are the issues of delamination of rubber-covered rolls and composition rolls at these speeds?*

Valmet: Delamination is a function of nip load and cycle frequency. In nip rolls, covers would be a problem.

Brown & Root: Rubber covered rolls will have to be re-configured especially in the suction roll area. Rubber covered rolls will become a thing of the past, and better roll cover materials will have to be developed.

TJ: *Are current dryers capable of being dynamically balanced for machine speeds of 10,000-12,000 ft/min?*

Valmet: The existing dryers probably are not able to handle these speeds without improved balancing methods.

Brown & Root: With 6-ft dryers turning at 1000 RPM, dryer redesign will have to be considered. Because of the additional precision needed in high speed dryers rolls, either roll diameters will have to increase to reduce the RPM or dryer shells and heads will require redesign to reduce the very high stress points at the interface. A combination of non-rotating and rotating dryers may be the answer. TJ