

21ST CENTURY PULP MILLS

DONALD G. MEADOWS

A LOOK AT FUTURE TECHNOLOGY CHALLENGES AND DEVELOPMENTS

WHAT ARE THE LIMITS OF CURRENT PULPING equipment and technology? How will pulp mills respond to advances in paper machine development? For this article, we asked pulp equipment suppliers and engineers to assume that speeds on the newest paper machine might double within a couple years. While that may be “impossible” it is not inconceivable. From a conceptual perspective, how would the pulping side need to respond to keep pace? Our responses come from Andrew J. DeGuire, director, product marketing, pulping and woodyard, Beloit Pulping, Nashua, NH; Robert B. Kinstry, director, process technology, Jacobs Engineers, Greenville, SC; Gunnar Carré, general manager, fiberline technology, Sunds Defibrator, Sundsvall, Sweden; and Lothar Pfläzer, head of Voith Sulzer’s Stock Preparation Division, Ravensburg, Germany.

TAPPI JOURNAL: *Could most modern mills double their on-site pulping capacity in terms of logistics, recovery, through-put, and emissions? What are the practical limitations to achieving that and how might they be overcome?*

Beloit: Absolutely not. Most older mills could and did double their capacity, but they were all built with far more excess capacity in the process equipment than is normal today. We’re much better at determining exactly what the maximum production of a given machine is today, so there is little production “fat” in a modern mill. A mill built today for 1500 tons/day might only stretch to 1600 or 1700 tons/day.

The only practical way to double the capacity of on-site pulping at virtually all currently operating mills would be to build another line, either the same size as the existing, or twice the size and shut down an old line. Note that doubling the capacity of a paper machine does not necessarily equal doubling pulping capacity unless there is only a single machine at the facility.

Jacobs: One of the first issues that a virgin mill is going to have to reconcile is the supply of wood and its cost. Going from 2000 tons/day to 4000 tons/day is going to almost double the distances that wood (fiber) will have

to be hauled. Hauling twice the distance suggests the need for satellite woodyards and increased use of rail for wood delivery either as roundwood or chips. If the mill happens to be on the coast, then the distances would be extreme, since they are already excessive.

The pulp producer would have to evaluate the practicality of a very, very large mill vs. two large mills — both from a wood supply and as an emission source.

The fiber supply question also raises the question of a long-term solution for fiber in North America. We need to develop a frost-resistant strain of eucalyptus and/or acacia that will improve our current yields per acre and approach the yields of South America and Asia. We do have a few cottonwood plantations in the Northwest and tracts of aspen in Wisconsin and Michigan, but as a whole we do not have much in the way of hardwood plantations. If we can develop higher fiber yields per acre, then the hauling distances may become a non-issue. The answer may even be in using nonwood fibers, but I don’t think we will resolve this issue in the next 10 years.

Mechanically, yes the mills can double their capacity. Water/effluent issues can be handled and may result in a net gain of “0” going to the environment. However, air emissions are a different issue. Any new mill will have to be built to meet the new tighter MACT II standards. Even so, there will be a net increase, almost doubling, for emissions. The expansion will trigger “prevention of serious deterioration” (PSD) review. A hog fuel boiler probably would have both an electrostatic precipitator and a scrubber to control emissions. Others would have to use high priced, low sulfur fuels.

Sunds: A typical modern mill might produce 1200-1300 tons/day of pulp. Actual production may exceed design capacity by 10% or even 15%. To double the capacity using the same equipment is impossible. To add more than 1000 tons/day of capacity, the mill would need to build a new parallel pulping line. That line could, of course, be built somewhat differently and at less cost than the original line. It is also cheaper to build new capacity into an existing mill (vs. a greenfield mill).

Voith: We believe this should be possible, at least by installing a parallel line using peripheral equipment like effluent treatment and recovery processes to the utmost.

TAPPI JOURNAL: *If internal pulp demand doubled at a mill due to machine upgrades and speed-ups, would most mills be better off to purchase market pulp or to expand on-site capacity?*

Belott: This would be very site specific and would depend greatly on the market price of pulp. Currently, the low market price and generally tight wood supply would rule out expansion in most cases, but this could change again in a few years.

Bob: The decision to purchase or produce pulp is related to grades to be produced on the paper machines. On a worldwide basis, the excess of market pulp is bleached eucalyptus and acacia from Asia and South America, which is ideally suited for printing and writing. But, even if left unbleached, eucalyptus would not be suitable for brown strength grades (high performance linerboard - at least until some R&D is conducted to determine how it can/should be used). The potential for the Asian producers to grow and supply eucalyptus pulp (estimated cash cost for production in Indonesia is about \$130/ton) to the world would suggest that an enlarged/doubled fine paper mill might want to use market pulp – provided that a long-term supply contract could be negotiated to stabilize pulp costs. Asian mills will also benefit from the fact they don't have to spend money to meet the "Cluster Rule" requirements.

A brown mill would have a difficult choice of either using OCC or virgin fiber. If wood were available, because of the uncertain price and volatility of OCC costs, I would have to lean towards the use of virgin pulp or a blend of virgin and OCC.

Sunds: With today's pulp prices, probably yes.

Voith: Market pulp may be a good solution to overcome short-term shortages and avoid big investments on the first hand, but in the long term, an expansion on site will more likely be advantageous.

TAPPI JOURNAL: *In order to double pulping capacity, what is the most likely engineering design scenario?*

Belott: There really is only one realistic option: a new fiberline. The only question would be whether to simply add the required incremental capacity, or build a larger line than is necessary, and shut down an older line or lines. It is practical today to build single fiberlines up to over 2500 tons/day, so there are no realistic restrictions on the size of a fiberline.

Jacobs: Installation of a new fiber line – either virgin or recycled, parallel to the existing line. For the virgin line this includes a parallel chemical recovery system. The size of the line would depend upon the size and age of the existing line. If the current line is old, and perhaps multiple units, then I would have to evaluate the possibility of installing a new, very large single line to optimize labor cost and efficiency.

Sunds: Essentially, everything one would typically expect for a parallel pulp line, with shared offices, control rooms, shops, etc.

TAPPI JOURNAL: *How would doubling pulp capacity affect the effluent treatment of a mill? Could most mill systems handle that or would that be the limiting factor for many mills?*

Belott: North American mills are moving ahead to meet the effluent restrictions mandated by the Cluster Rules. Since this will already be pushing the envelope, doubling pulping capacity in the future will mean new and larger systems for dealing with effluent. In many cases, this could be the limit due to real estate restrictions, or will force the limit to become our ability to build the so-called TEF or "totally effluent free" mill.

Jacobs: It is highly unlikely that the existing waste water system could absorb doubling of the influent load. Thus there are two approaches can be taken 1) instituting measures to close up the mill with a resulting "no increase load" to the wastewater system or 2) double the size of the system. The later I believe would not be acceptable to the environmental authorities. Thus the logical approach is to "close up" the mill. It is difficult and expensive to reconfigure an existing mill to "closed cycle", due to the infrastructure (piping, sewers, etc.). However, designing a mill, either virgin or recycle, from scratch for "closed cycle" operation is technically viable and can be cost effective. Thus, a new "closed cycle" fiber line coupled to an existing line can probably be handled with some minor modifications to the existing system.

Sunds: A new pulp line would produce less effluent, by volume, than older designs of comparable capacity. A modern, press-based bleach plant only produces 7-8 m³/ton in effluent volume, which is less than half the volume associated with a standard "modern" mill.

TAPPI JOURNAL: *Is the current chemical recovery process adequate for the future? Can it be scaled up to meet the demands without creating capital cost nightmares?*

Jacobs: The Tomlinson recovery boiler is very adequate for a large pulp mill. The technology is mature, has high reliability, and is safe when operated properly. Recovery boilers have been built to process about 8 million lbs/day dry solids. Based on past discussions with boiler designers, I believe they would be comfortable building an 8.5 million lbs/day unit. At 3,500 lbs/ton this is equivalent to about 860,000 tons of pulp per year. Can they be scaled up beyond that? Maybe yes! A major issue is going to be — how to get the liquor distributed within the very large hearth. There may be a practical limit to the distances we can spray liquor from the sides of the furnace — this will limit the physical dimensions and thus the capacity. Maybe the units above 8.5 million lbs dry solids will have split hearths with a common upper furnace.

To control non-process elements — the causticizing/kiln system would use the best available technology.

TAPPI JOURNAL: *If it isn't adequate, what needs to change in chemical recovery? The furnace, the kiln, the process?*

Jacobs: Ideally we need to work on reducing the operating/fuel cost for the causticizing operation (i.e. lime kiln).

TAPPI JOURNAL: *What options within the AF&PA Agenda 2020 Gasification Whitepaper offer the most promise for getting additional capacity from existing recovery boilers?*

Jacobs: Black liquor gasification technology is ready to be used as a means to supply incremental capacity for a mill. However, gasification technology is not ready to replace a very large Tomlinson recovery unit. Too many questions about scale-up and reliability still need to be answered. Will it be ready in 10 years? That depends upon the industry. Several small units, or progressively larger units, will have to be built before the industry will be ready to risk installing one with the capacity equal to the largest Tomlinsons. Will it happen in 10 years — probably not due to the current level of capital spending — not enough funds are available to install the initial small units required. The state of the market will limit the expansions needed to test the technology.

Driving force for gasification is overall energy efficiency, i.e., conversion of fuel (black liquor) to useful energy. Gasification has the potential for direct and/or auto causticizing. Also, gasification of black liquor coupled with a combined cycle turbine can produce more electricity than a Tomlinson unit.

TAPPI JOURNAL: *Will the kraft pulping process remain dominant for the next decade or will we see more pulp production come from mechanical or biopulping processes?*

Belott: Yes, but look for newer processes such as ASAM to begin to break ground.

Bob: In a word — YES! However, I believe that we will try to improve the pulp yield by use of more selective treatments, i.e. systems that attach lignin without dissolving good cellulose. Biotreatment will be one of the techniques that will grow. Also, we will see much greater use of anthraquinone/polysulfide (AQ/PS) systems.

I believe that we will use more mechanical pulp. We need to develop grades of paper that use mechanical pulp and can be used in desk-top printers and copy machines. As a society we throw away too many copies after a test printing or a short period for all copy/prINTER paper to have the longevity supplied by use of 100% chemical pulp.

Sunds: The kraft process will remain dominant.

Voith: It seems chemical pulp might have better growth rates in the future than TMP. However, this is very difficult to predict as other factors, such as environmental and political pressures, could have an influence.

TAPPI JOURNAL: *Would it be more feasible to add some capacity from a recycling operation instead of increasing the chemical pulping capacity at a mill? Why?*

Belott: This is an economic decision. Recycled fiber does not usually directly replace virgin fiber in the same product, so the product produced by the mill changes. There are many other ramifications to changing part of the supply to recycled fiber, including a new and different source of effluent, a different raw material source, and different markets. In general, to increase production of the same grade of paper, the pulping production will need to increase in kind. In fact, if the increase in production by the paper machines is due to increasing speed on the same machines, they will likely be less tolerant of lower quality fiber sources such as recycled fiber.

Jacobs: Recycle will be, and must be, a part of the future fiber supply. In order to eliminate some of the recycle issues, i.e. stickies, we will work with fiber use systems. What is a fiber use system? In my mind it is system that looks at the life cycle of fibers, and eliminates components that render them unusable, or difficult to recycle. We will come up with alternative adhesives for stamps, post-its, etc. that cause stickies. We will also come up with

systems that allow us to economically recover and reuse other contaminants, such as plastic, that are contained in the recycle fiber stream.

Sunds: Yes, if the quality of the recycled pulp is good enough. The advantage is in not increasing the load on the recovery system. The effluent system will have to be upgraded, however. For most paper characteristics, mixing 50% recycled with 50% kraft pulp won't match the quality of 100% kraft pulp.

Voith: Definitely yes, because the process technology is available to convert reclaimed fiber such as mixed office waste to pulp comparable to virgin pulp. There is a system in operation at UK Fiber Kemsley which produces such a pulp, with excellent results.

TAPPI JOURNAL: *What challenges might a recycling mill face in trying to increase the speed or capacity of its operations in response to increased demand from a newsprint or fine paper machine?*

Beloit: The most significant challenge to any recycling operation will be simply keeping up with production, let alone increasing. This is because in virtually every area, the quality of raw material is getting poorer as collection becomes more universal and complete. As the quality of the raw material drops, capacity of most of the pulping equipment decreases. Increases in capacity will necessarily require investment in new equipment.

Jacobs: Major challenges include how to operate at high machine speeds and efficiencies, while producing the required paper qualities (including strength, brightness, etc.), at minimum basis weight while using a weak fiber.

Machines will be closed draw until the sheet is dry. Pulp defects will be removed through improvements in screening/cleaning/deinking technology. Additives will be created to improve paper properties. We may see paper made from composites of cellulose and "something," and the end product will have to be recyclable.

Voith: Recycling mills are normally easy to expand, as the individual process steps can be increased in capacity by adding stock prep machines. No boilers or other large equipment is involved.

TAPPI JOURNAL: *How might fiber supply limit the ability to double pulp mill capacity and how might those potential obstacles be overcome?*

Beloit: We are already there. Fiber shortages and associated high costs, particularly in the west, are reality today. New sources of fiber, in ways ranging from better silva-

culture and newer, more productive species of tree, to annual fibers such as wheat straw and corn stalks are essential to any overall increase in capacity. Higher yields from pulping processes will be another important part of the picture.

Jacobs: Distances to haul wood and waste paper will be issues that will have to be dealt with. Maybe the mill of the future is a very large version of the mini-mill, a maxi-mill. A one-machine mill, capable of producing several thousand tons per day, that can draw upon the raw materials (fiber) within an economic supply zone.

Again, I believe North America needs to develop species of fast growing trees, especially hardwood.

Voith: Even countries with very high recycling rates, such as Germany, whose rate exceeds 50%, still export recycled paper. This clearly indicates there is enough fiber available, provided the collection system is well organized.

TAPPI JOURNAL: *What is the 10-year horizon for pulping technology?*

Beloit: There will be limited new capacity added with an increased emphasis on effective use of recycled fibers. Any real capacity increases in virgin fiber will come from Asia and South America, where the size of new fiberlines will increase to the truly gigantic scale. We can foresee 3000 tons/day single fiberlines or even larger.

In North America, the focus will be on efficiency and the environment. We expect limited investment in new equipment compared to the past.

Jacobs: I don't see any quantum jump in the current fundamentals. Money just isn't being spent on the basic R&D. In fact, R&D organizations continue to be dismantled (i.e., the recent Union Camp announcement).

Sunds: The future will see:

- effluent free mills
- 3000+ tons/day pulping in a single line
- tailor-made pulp production for different paper grades
- reduced investment costs/ton of pulp production.

Voith: The recycling systems will improve further to match the quality requirements for SC, LWC and fine papers as they did in the past with newsprint. **TJ**

Meadows is editor of TAPPI JOURNAL.