

Modern and efficient paper and board sheeting practice

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We must strive for 100% efficiency and high productivity with today's sheeting systems.

Sheet cutting—the production of finished-size sheets from reels of material—has been in evidence in one form or another since the introduction of the first web-to-reel papermaking machine more than a century ago.

In the past 20 years or so, technological changes in the paper industry have been phenomenal. Papermaking is often computer controlled throughout the process. Paper machines are capable of very high speeds, and the conversion of reels to sheets, whether within the mill or at independent converters, is done with high-speed precision designed for high levels of performance within defined parameters.

The industry has changed from being a labor-intensive business to a business requiring high capital expenditures to achieve targeted return on investments. The machines must be very productive. Any sheet-cutting system is not making profits if it is not producing a salable product in sufficient quantity to give an adequate return on investment. Near-perfect material is expensive to manufacture, and the sheet-cutting system must enhance and optimize this value.

Modern sheet cutters must meet the following objectives:

- High output
- Precision-cut sheets
- Minimum downtime
- Low waste.

Two features are required for high output: reliable top running speed and continuous-running features.

Five major features give precision cuts and control: a cutting head that gives true shear cutting action throughout the sheet range, heavy-duty slitting with a preset slitting angle and pressure that creates a clean slit edge, a microprocessor that controls sheet sizes, web inspection for splices, tearouts, creases, holes and wrinkles, and sheet counting to provide an accurate number of good sheets.

Two features are essential to reduced downtime:

1. Aids to help the operator keep the system running, such as pushbutton control of sheeter functions, pro-

grammed slitters, automatic stack change without stopping the machine, and either large-diameter rolls to gain longer running time or splicing units

2. Factors to reduce maintenance and breakdowns, such as heavy-duty mechanical elements, proven electronic modules, programmed preventive maintenance, skilled technicians, and adequate spare parts and good after-sales service from suppliers.

Five important features help keep waste to a minimum: correct counting of salable product, faulty sheets rejected or easily identified, minimum trim to give correct sheet size, correct decurl of material to produce a flat sheet, and adjusting rollers to eliminate creasing.

We find today that the modern sheet-cutting system meets, to a large extent, the requirements and criteria dictated by the marketplace to achieve high output and minimum downtime.

This can be expressed in terms of efficiency as:

$$T_p = T_i \times E\% \quad (1)$$

where

T_p = practical metric tons/h

T_i = theoretical metric tons/h

$E\%$ = percent efficiency.

$$T_i = W \times S \times 60 \times N \times \text{grams per square meter} \times 10^{-6} \quad (2)$$

where

W = web width, m

S = speed, m/min

N = number of reels.

$$E\% = (T_r \times 100) / T_r + T_d \quad (3)$$

where

T_r = actual time to run reels, min

T_d = $S_i + R_i + P_i$

S_i = time to set main cutter, min

R_i = time to load reels and feed webs, min

P_i = time to change pallets per reel set, min.

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The efficiency factor ($E\%$) is based upon downtime relating to the sheet-cutting system. Any downtime not directly attributed to the sheet cutter's limitations is not included. For example, it does not include time when the operator is not available, when there are no pallets ready for changing, when there are no reels available, a planned machine shutdown, shift changes, or poor-quality material to be sheeted.

To be meaningful, the calculation as given must relate the $E\%$ achieved, coupled with T_p . If we assume that T_d remains constant, then

$$\begin{aligned} \text{For } S \text{ cutters operating at speed } n, \text{ then } E\% = E_1 \\ \text{If } S_2 > S_1, \text{ then } E_2 < E_1 \\ \text{If } S_3 < S_1, \text{ then } E_2 > E_1 \end{aligned} \quad (4)$$

This shows that although E_2 is less than E_1 , T_p will be more. Conversely, although E_2 is greater than E_1 , T_p will be less.

Therefore, one must be careful when looking at "efficiency values" as a percentage of available time, because by themselves they do not fully indicate "true" operational productivity. In reality, "efficiency values" related to actual output in metric tons per hour is more meaningful.

Similar to most manufacturing process lines, the predicted production from the sheet-cutting system in metric tons per hour is dependent upon many factors. Any one of several variables from both inside and outside the organization can readily change the ratio of actual output to predicted production: changes in order quantities, changes in product mix, changes in reels-sheets ratio, reels of incorrect size, reels of inferior-quality material, or an order program that does not allow the sheeteer to operate at its full potential.

Developments in modern sheet-cutting systems now include features that go a long way toward accommodating these variables:

- Quick sheeteer size change
- Sheet cutters with greater flexibility to cope with differing densities of material
- Ability to cater to differences in unwind tensions produced either by slitter/rewinders or the paper machine
- Rejection of poor or damaged material.

Targeting for 100% efficiency and high productivity

If we look at the calculations relative to $E\%$ we find:

$$E\% = (T_d / T_r + T_d) \times 100 \quad (5)$$

Theoretically, the only time that $E\%$ equals 100% is when T_d equals zero.

Current modern sheet cutters can and have reduced the time taken to set up the machine and to change pallets.

The area to attack which will in most cases reduce downtime is the time to change reels and feed the web to make it ready for running. In effect, the machine is stopped during this cycle. However, there are certain avenues that should be explored to reduce this time:

- Use large-diameter reels.
- If larger-diameter reels are not possible, consider using turntable or shuttle cars.
- Consider some form of automatic splicing.

The simplest solution is to produce larger-diameter reels since this has an immediate effect on efficiency. Figure 1 shows that changing from 1000-mm-diameter to 1500-mm-diameter reels can significantly improve the production (more than 15%).

Together with the pallet-change system, larger-diameter reels will yield even more production (Fig. 2).

Sheet-cutter manufacturers are able to provide the technology and advice to improve productivity for the paper and board manufacturing industry. High productivity and 100% efficiency is the ultimate target, but the industry must cooperate to achieve this goal.

Developments in other markets

So far, I have emphasized the traditional paper manufacturing industry over the last 30 years. However, in that same period, sheet-cutting systems have been developed for materials other than paper and board.

We have seen the growth in specialized coating, encapsulated pressure papers, preprinted paper, laminated and foil-lined board, and clay coated (lightweight coated) paper to mention a few.

Each of these new products has required specialized development of sheet-cutting systems to successfully produce finished acceptable sheets for their growing markets.

Nowhere is this more evident than in the growth in printed labels for the drinks market (i.e., bottles). Modern sheet-cutting systems are capable of producing sheets from a preprinted web to a registered, consistent accuracy of better than 0.2 mm at cutting speeds in excess of 400 revolutions/min.

As a spin-off from these developments, the technology was modified for very accurately cutting everything from sheets of personalized and high-security watermark papers to registered keymarks made on the paper machine.

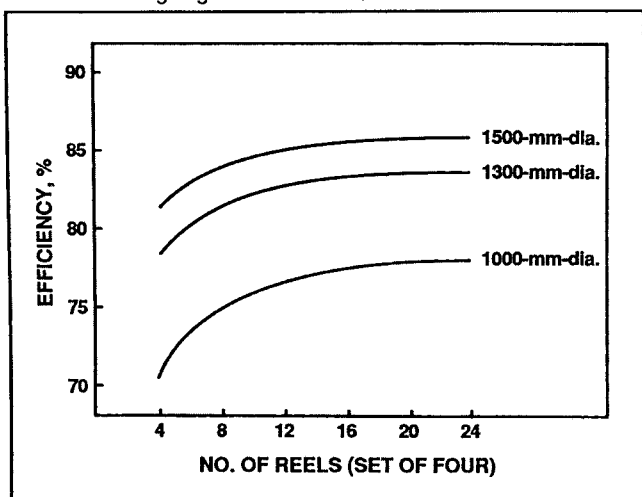
As new markets develop and new materials are subsequently sold in sheets, modern sheet-cutting systems must adapt and be flexible to meet new challenges and to understand the industry's needs to achieve desired productivity and profitability.

Future developments in sheet-cutting systems

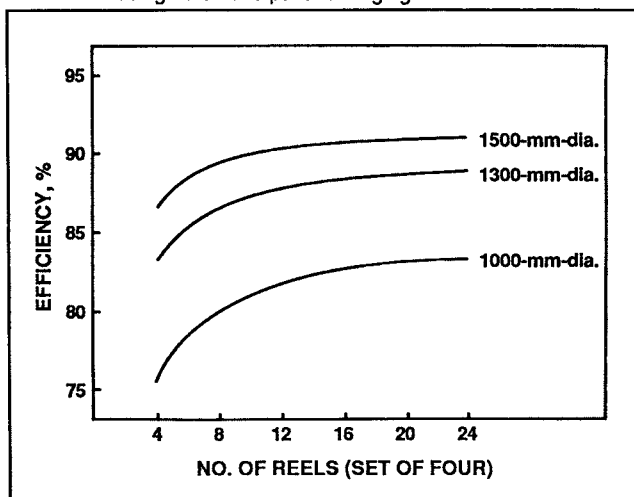
If we look at the industry historically and with our current knowledge of market needs, we might predict these developments for the future:

1. We have computer and information systems available to direct, program, and implement information to and from sheet-cutting systems.
2. Due to the high capital investment required to establish modern sheet-cutting systems, they must produce more than earlier systems.
3. Base material and energy costs are high, and there is every indication that these costs will increase. There-

1. Effect of using larger-diameter reels



2. Effect of using automatic pallet changing



fore, waste will be viewed more critically, and it will be critical to find ways to reduce waste.

4. Staff experienced in older craft skills progressively will be replaced by technicians.
5. There will be a continuing emphasis on two major markets for sheet-cutting systems: dedicated, very specialized, high-production sheeters and flexible, high-production sheeters able to satisfy more than one market.
6. More automation of the functions within the finishing salle will be incorporated, enabling better control of throughput.

Now let's investigate these indicators in more detail and forecast their effect on sheet-cutting systems.

Computer and information systems

Computer-controlled papermaking and the integration of orders and stock levels to regulate the manufacturing cycle are well established in the industry.

It won't be long before slitter/rewinders, sheet-cutting systems, and wrapping and packing facilities will be incorporated into the computerized system. The computer will not take just one aspect of the manufacturing cycle; it will embrace the total potential of the production machines to ensure maximum efficiency of operation, control of the quality, and the most cost-effective way of producing the final product.

High productivity

Previously, we examined the main factors that contribute to downtime, and these can form the basis of future developments to ultimately eliminate the detrimental effect on productivity. However, the computer will be used to optimize the number of reels and the caliper, to take advantage of the best slitter and cross-cut knife loading, and to determine the best speed curve for the required productivity. The computer controls will determine throughput, and if for any reason the target is not being reached, it will give instructions for whatever remedial action as required.

Waste

This is always one of the significant factors eroding profits in the industry and is an issue that will warrant continuing investigation in the future. Unfortunately, the more individual work centers and handling points within the total process, the more chances of waste being created.

Within the sheet-cutting system "waste" can arise from the following:

- Preparing reels for sheeting
- Setting up the machine
- "Flare up" or paper jams during high-speed running
- Incorrect counting
- Roll ends
- Quality of material
- Splices and tearouts
- Trim from reels.

Quality of material and splices and tearouts are within the control of the manufacturing processes preceding slitting and should be viewed separately. For now, we'll consider the other sources of waste in more detail.

Preparing reels for sheeting. Good housekeeping requires careful inspection of the reels so that when they arrive for sheet cutting they are not damaged on their ends or across the face widths.

Setting up the machine. Modern sheet-cutting systems can be set to produce the required sheet size without running material because of electronic sheet length and squaring modules. This development and ongoing refinements represent a significant contribution to waste reduction.

"Flare up" or paper jams during high-speed running. Control of sheets at high production speeds is necessary to give reliability and consistency over a broad spectrum of substrates.

Incorrect counting. Incorrect counting is considered "waste" because profits decrease if customers receive more sheets than they ordered. No customer ever complains about receiving more than he or she ordered

Roll ends. Problems with roll ends is a subject that

requires examination to help eliminate waste and sustain high productivity. This is viewed under two categories:

1. Reels of differing wound lengths of material.
Often reels being converted on the sheet cutter are not wound to the same length. During the sheet-cutting operation, as sheets expire there is an ever decreasing number of reels to be cut. Combine this with a likely reduction in speed, and anticipated productivity declines.
2. Material curl problems.
Material curl problems tend to become more evident as the reels near the core. If it is an inherent problem in the material, and if existing decurling systems do not eliminate the problem, then larger cores must be considered. In any sheet-cutting system, curl problems mean more waste, a reduction in speed, and low productivity.

Trim from reels. Losing trim from the edges of the reels during the conversion to sheets produces waste. Edge guide devices with electronic controls to give guidance accuracies within 0.5 mm are currently on the market. However, these are not being incorporated in the majority of new installations. Too often reels from the slitter/rewinder are produced too wide (compromising for an earlier operation), or slit edges do not meet quality standards. Computerization and good housekeeping could eventually lead to "no trim loss," thereby increasing profitability.

Staff changes

Greater emphasis will be placed on eliminating the need for special skills to set up and operate sheet cutters. Computer controls integrated with production instructions to the sheet cutter will increase, and this will require qualified technicians rather than craftsmen to operate, maintain, and understand the sheet-cutting systems of the future.

Markets

There will always be two main markets for sheet-cutting systems: one to satisfy mass producers in specific and well-defined markets requiring dedicated sheet cutters and the other requiring machines that are flexible and can be used for a variety of substrates and materials.

Automation

Automation already exists for reel handling, reel wrapping, pallet strapping, and wrapping. However, as computers are more extensively used to control other process manufacturing segments, total integration of the system will mean complete controls throughout the total work cycle.

Conclusion

This analysis and evaluation of efficient sheeting practice illustrates that there are at least two solutions to any drive for efficiency: a simple solution, such as larger reels, and a sophisticated solution such as a digital sheet length and squaring monitor. Whichever end of the spectrum you choose, answers can only come from a thorough understanding of the sheet finishing market. □

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