Find the Money Hidden in Your Drying Process

Using less energy in the drying process can literally save a marginal mill from extinction or turn an average mill into a higher profit producer. So what are we waiting for? It's time to elevate energy efficiency to a level of importance equal to production and product quality.

By Gregory L. Wedel

After years of neglect, many papermaking processes have drifted into a rut in which they are competitive only when energy costs are low—a situation that is not likely to return. Fortunately, there are significant opportunities to reduce the amount of energy used and even to generate energy that can offset the cost of purchased power.

By placing the dryer section first on the list when it comes to energy savings, a return of millions of dollars per year is possible, if we are willing to focus our own energy on this task.

CUTTING WATER USAGE—THE FOUNDATION OF BIG GAINS

The amount of energy consumed in drying is directly proportional to the amount of water that must be evaporated. The amount of water that must be evaporated from the paper includes the water that is not removed in the press section as well as the water that is added at the size press, coater, and various re-moisturizing devices.

An improvement in press dryness, for example, from 38% to 42% reduces the drying load by nearly 16%. That equals a savings of $1.20 million for a 1000 tpd mill. Even for a 250 tpd mill, it represents over $300,000 in savings per year. And that is at yesterday's energy costs.

ENERGY SAVINGS AND STABILITY ARE ONE

Energy consumption can be reduced during both steady-state and non-steady-state drying processes. Obvious areas of focus for energy conservation during the steady-state drying process include:

- Improve the pressing efficiency (sheet dryness)
- Reduce the amount of over-drying before the size press
- Apply starch and coating at high solids content
- Reduce the amount of over-drying before and after coaters and size presses
- Eliminate venting of steam to atmosphere and condensers
- Adjust the ventilation air flow to match production
- Recover heat from the air exhaust

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In addition to improvements during steady-state operation, minimizing production upsets can also reduce energy consumption. *The energy consumed in idling the dryer section can be nearly as high as during full production.* Improvement opportunities during production upsets include:

- Reducing grade change time
- Reducing the number of sheet breaks
- Reducing sheet break recovery time
- Adjusting steam system during upset conditions
- Adjusting ventilation system during upset conditions

Using a lower "quality" of energy to dry the paper can also reduce the cost of energy. Specifically, reducing operating steam pressures, using less high-pressure thermocompressor motive steam, and reducing operating differential pressures do not reduce the amount of energy, but they do reduce the quality (cost) of the energy that is used.

Some examples of machine upgrades that might be considered include:

- Installing runnability components to minimize breaks and threading time
- Updating the steam system to eliminate venting of steam
- Installing steam and condensate supervisory control systems
- Installing dryer bars to increase heat transfer rates
- Installing stationary syphons to reduce operating differential pressures
- Upgrading dryer ventilation system (hoods, fan controls, and air distribution)
- Installing ventilation system supervisory control

LESS VENTILATION, LESS ENERGY

A significant amount of air is required to ventilate the dryer section. A typical fine paper machine that is producing 1000 tpd would require nearly 25,000 tpd of dry air to ventilate the evaporated water. This large volume can be significantly reduced, not only by upgrading to modern, high-humidity hoods, but also by modulating the air flows to match the actual drying requirements. Unfortunately, in many cases, papermaking machines are running at less than design production and operated using the entire ventilation system capacity. As a result, tremendous amounts of energy are lost in the air exhaust. This energy can be recovered, but it is best not to use it in the first place.

DIFFERENTIAL CONTROL MAKES A DIFFERENCE

One of the least monitored and largest losses of energy comes from the dryer section steam and condensate system. For many mills, the steam system is a "black box" operation. As long as the sheet is being dried during normal operation and the dryers do not flood during machine upsets, the system is assumed to be working. In fact, the steam system may be venting massive amounts of energy, through vents in the roof and to vacuum condensers.

An improperly designed steam and condensate system can easily result in live steam being vented during normal operation. Venting can also occur during sheet breaks, when the thermocompressors go out of range and operating differential pressures are too high for the reduced condensing load. A steam system audit can identify the venting losses, causes, magnitudes, and corrective actions. Calibration of differential pressure transmitters, operator training, installation of low-differential, low-blow through stationary syphons, and operating with managed differential pressures all help to reduce the potential for energy losses in venting steam.

FLATTEN PROFILES

Non-uniform cross-machine moisture profiles can result in a loss in product quality, poor machine runnability, and high energy consumption. Profiles can be corrected with profiling steam boxes, rewetting showers, and over-drying. None of these correction devices, however, are energy efficient. The best approach is to produce a moisture profile that does not require correction. Uniform profiles can be achieved with controlled press roll profiles, uniform pocket ventilation, and properly applied dryer bars. The impact of improved moisture profiles on overall operation can be quite significant and is often underestimated.

TAKE THE PRESSURE OFF POWER GENERATION

Another one of the missed opportunities for energy reduction is the potential for using more low-pressure make-up steam in place of high-pressure motive steam to dry the paper. Although the change in steam source does not change the *amount* of energy required to dry the paper, it does affect the *cost* of the energy that is being used.

For example, when a paper mill produces both steam and electrical power (co-generation), high-pressure steam can be used first to generate electrical power and then to dry the paper – provided that the lower-pressure steam from the turbine exhaust is still high enough to provide the required drying capacity. The addition of dryer bars helps to reduce the steam pressure requirements, making this option more feasible.

The addition of stationary syphons further helps by increasing the average steam pressure in the dryers, reducing the boost required from the thermocompressors, and reducing the amount of steam that must be recompressed. With proper thermocompressor sizing, the amount of motive steam that is required can be reduced by a significant amount, often by more than 50%. And, with proper system design, it may even be possible to operate a cascade system and entirely eliminate the use of high-pressure motive steam.

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The reduction or elimination of high-pressure motive steam use allows more electrical power to be generated by the power turbines, reducing the amount of electricity that must be purchased.

LESS LOAD ADDS UP

Another often-overlooked opportunity for energy conservation is the reduction of the dryer drive load. In some low-speed machines, the installation of dryer bars will push the condensate into a rimming mode, thereby reducing the amount of power required to drive the dryers.

To put this change in perspective, the reduction in drive power (rimming versus non-rimming condensate) for (34) dryers with a 3300 mm trim at an operating speed of 500 mpm results in a savings of approximately $54,000 per year. This savings excludes the value of reducing dryer gear maintenance and eliminating periodic gear failures. This energy savings opportunity is often overlooked for two reasons: 1) The energy loss is not seen, as long as the installed drive capacity is adequate to turn the dryers; and 2) most guidelines limit the application of dryer bars to machines operating over 500 mpm.

SIMPLIFY DRYING AUTOMATICALLY

The steam system for a dryer section can be properly designed and fully capable of operating at peak energy efficiency and yet never operate that way. The causes are as varied as they are numerous, but they all fall into one of four categories: Lack of training, lack of maintenance, lack of discipline, and system complexity.

To further complicate the problem, steam and condensate systems are often viewed (and even designed) as a "black box". A steam and condensate system that is capable of operating at peak energy efficiency invariably has many complicated interrelationships between control loops that must be adjusted in coordination with the machine operation and all of the other controllers. The level of complexity required to manage such a system requires the combined input of control experts, steam system designers, and process engineers.

Consider that advanced computer controls are required to manage only a dozen control loops to land a modern jet liner. These advanced computer controls have helped establish a record for aviation safety, reliability, and efficiency. By comparison, a typical dryer drainage system has more than 50 different and interdependent control loops, and yet we expect an operator to manually adjust each of the operating set points and compensate for sheet breaks, grade changes, start-ups, and shutdowns. This is asking too much.

As an alternative and more rational approach, operators can use a supervisory control system that *automatically* accounts for the response characteristics of dryers, syphons, thermocompressors, control valves, and all of the associated papermaking processes, leaving the operator with time to focus on the business of making paper.

Advanced monitoring, diagnostic, and supervisory control systems can simplify the operation of the steam system and reduce the number of controls that the operators must attend to, allowing them to focus on production efficiency and product quality with the lowest possible energy cost. Using less energy and reducing our "carbon footprint" is good for all of us. For some, it's a matter of survival. ■

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