STAYING IN CONTROL

Improving Flake Blending and Mat Forming in Older OSB Mills

by Sergei Kuznetsov

OSB manufacturing technology has changed significantly since the first commercial plants were constructed in the late 1970s. Advances in process technology and control systems have helped new mills manufacture quality products with greater efficiency.

However, older mills—ones built in the 1970s and 1980s—often lag their newer counterparts in embracing more automated operations. Control algorithms developed for newer mills don't work well in older mills, sometimes simply because of large transport delays that result from using lengthy conveyors connecting process equipment spread over mostly flat plant floor layout.

The problem is especially pronounced in the blending and mat forming areas, which are the key areas affecting product quality and consistency. It is not uncommon to see operators of an older mill trying to manually control wood flow into blenders and maintain desired levels in forming bins. Operators have dozens of other activities requiring their attention and sometimes don't notice a problem with a forming bin level on manual control until too late. This results in having to shut down some equipment or the whole forming line.

It is obvious that the task of controlling flows and levels should be handled by the control system. A conventional PID (proportional-integral-derivative) feedback controller will not work well in applications with long process deadtimes. Good control can be accomplished, even in older mills, by employing the Smith Predictor control algorithm to address processes with significant transport delays or deadtimes.

Addressing Deadtime

New mills solve the problem of controlling forming bin level by employing PID-based controllers. One configuration uses a PID level controller to directly manipulate the corresponding dry wood bin live bottom conveyor speed. Another configuration cascades the PID level controller to a PID conveyor speed controller that controls the dry wood flow. The cascaded loop provides a more constant wood flow rate at the blender inlet and thus improves the blending process.

The deadtime associated with the conveyors of an older mill reaches five minutes in some extreme cases and prevents this simple control strategy from working properly or at all.

Deadtime is the result of material (flakes) being transported from the site of the actuator to another location where the sensor takes its reading. The sensor detects changes caused by the actuator only after the material has traveled all the way from the actuator to the sensor. The table nearby shows sensors, actuators, and deadtimes for both loops at a typical old mill.

Process Area	Sensor (Process Variable)	Actuator (Manipulated Variable)	Typical Deadtime
Blending wood flow	Weight scale graduated in lbs per hour	Dry wood bin live bottom conveyor speed	30 to 150 seconds
Forming bin level	Forming bin level transmitter	Blending wood flow controller setpoint	60 to 150 seconds

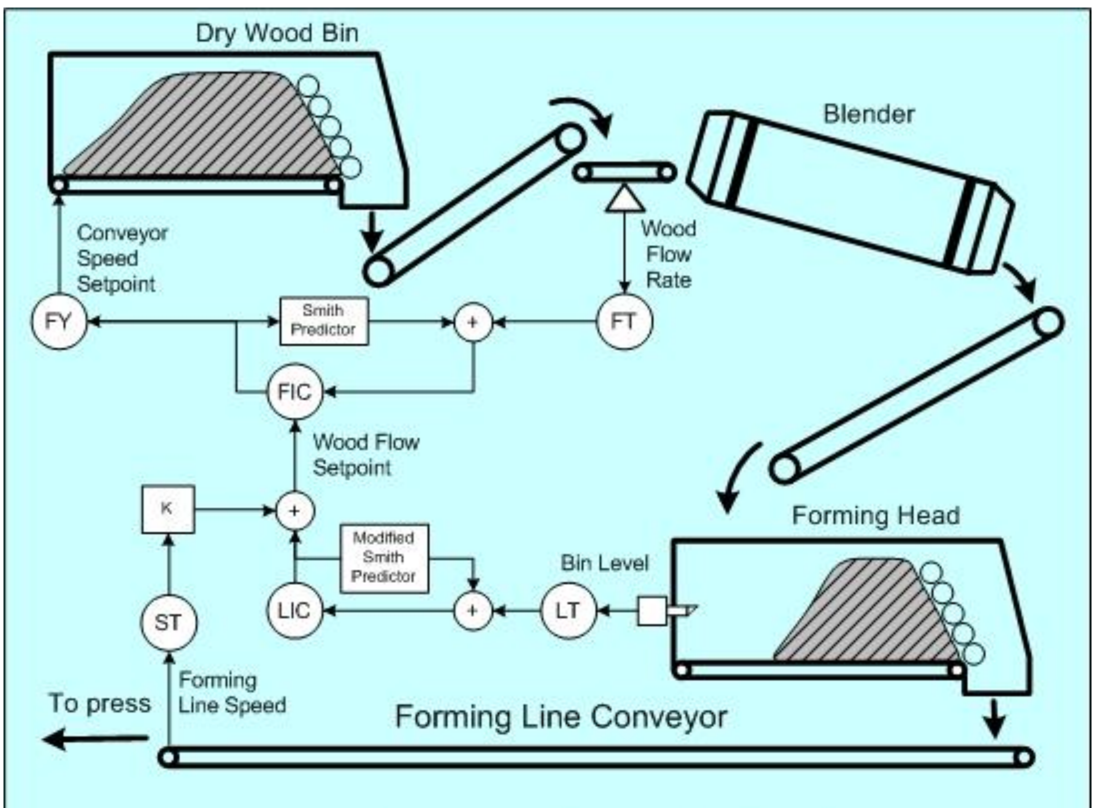
If the process deadtime is ignored, then a wood flow controller will receive actual flow rate and adjust the corresponding dry wood live bottom speed. However, it will take time for the requested amount of material to reach the weigh scale. In the meantime, the controller will determine that the last correction was not enough and will request increasingly larger corrections until the weigh scale finally "sees" the change. By that time the controller will have overcorrected for the original error and it then begins reversing its corrections. This results in instability and often causes oscillations.

One way to eliminate the oscillation is to detune the controller, which slows its response down. Large deadtimes present at older mills require serious detuning to the point where the controller is not able to provide quality setpoint control.

This problem can be solved by the use of a control algorithm called the "Smith Predictor." It was proposed in 1957 by O.J.M. Smith of the University of California at Berkeley. This famous algorithm is widely used in refineries to control gas composition being measured by on-line chromatographs with deadtime measured in minutes, on rolling mills to control sheet thickness, and in other applications where material is being transported from the site of the actuator to another location where the sensor takes its reading.

The Smith Predictor uses a process model to calculate predicted process change in response to a control action as if there is no deadtime. This change is added to the PID process variable so the controller is made to "believe" that the corrective action actually took effect immediately, and thus will not take additional action. With such a modification the PID controller can be aggressively tuned so it can provide good control of its process variable.

Since a cascaded level/flow controller offers more benefits for the mill, only this option is considered in this article.



Forming Head Level Control for One Head

Blending Wood Flow Control

Dry wood flow entering a blender originates in the corresponding dry wood bin with a "live bottom" conveyor driven by a variable speed drive (the actuator). The drive speed is adjusted to control the amount of wood flakes discharged from the bin. The time it takes the material to travel from a dry wood bin discharge to the blender inlet could vary from several seconds to as mach as 150 seconds in some extreme cases. Dry wood flow, as measured by a weigh scale graduated in flow units (lbs per hour, for example) positioned before the blender inlet, is used as a reference for resin and wax injection in the blender.

Wood flow can experience significant deviations due to irregularities in the wood pile shape inside the bin. Some mills have more than one bin feeding a particular conveyer. When operators switch bins around they introduce additional disturbances into the process. While operators do their best to keep wood flow as steady as possible, a PID controller, equipped with the Smith Predictor described earlier, can be aggressively tuned to provide very good automatic control.

Such a control strategy has been implemented on three OSB production lines with positive results. Dry wood flow controllers are now in automatic mode most of the time. Operators, who no longer need to manually adjust the live bottom speed of several dry wood bins, are able to dedicate more time to other tasks. Steadier wood flow helps maintain the proper ratio between wood and wax/resin in the blender.

Forming Bin Level Control

Maintaining material in a forming bin at the desired level has been notoriously difficult in older OSB mills. Regardless of who is in charge of this control—the operator or an automatic controller—level in forming bins often wanders out of the desired range. The reason is the presence of a large deadtime caused by long conveyors and blender retention time.

These swings present a serious problem for the mill. If level in one of the bins is too low, then the forming line has to be shut down. If the level is too high then the corresponding feeding conveyor chain has to be stopped and the blender put in high speed mode to keep flakes inside. Unstable forming bin level may affect mat weight consistency and thus increase board weight variation.

Developing an automatic controller for forming bin levels thus offers an opportunity to significantly improve operation of this process area.

A PID-based level controller coupled with Smith Predictor can be used to solve this problem as well. In this case the actuator is the flow controller setpoint. The sensor is the forming bin level transmitter. A change in the flow setpoint will lead to a change in the level value. The model used in the Smith Predictor accounts for the deadtime so that the PID loop can be tuned aggressively and provide tight control of the level in the forming bins.

The level controller thus becomes the "master" that calculates the needed wood flow setpoint for the "slave" blending wood flow controller. When a forming bin level gets too high, the master sends a lower flow setpoint to the flow controller. If the level gets too high, flow setpoint is reduced. Both slave and master have their respective process deadtimes compensated by the Smith Predictor algorithm, so the cascaded pair works almost as if there is no deadtime at all. Of course, an analog level measurement needs to be available for the PID-based algorithm to work properly. Laser level meters have proven to be very effective in this application.

While use of the Smith Predictor to address transport delay problems is quite common, it is complicated in this case of the forming bin level due to the integrating nature of the controller process. What that means is that if the incoming wood flow rate is changed from the rate required to maintain constant level, the level in the bin does not settle at a new value but instead starts to drift until it eventually reaches one of the limits. A number of modifications of a basic

Smith Predictor have been proposed since 1994 for controlling non-self-regulating processes with large deadtime.

Conclusion

The system allows two modes of operation—manual bin level control (flow mode) wherein the operator adjusts the wood flow controller setpoint to maintain the desired bin level, or automatic bin level control (level mode) wherein the forming bin level controller is cascaded to the wood flow controller.

Using the system in flow mode stabilizes wood flow and thus improves blending operation and simplifies the operator's task of manually maintaining the level in the forming bins. Some configurations can produce flow swings which cause plug-ups and line stoppages. The frequency of these events is reduced with a more stable wood flow.

However, the greatest benefits are received when the system operates in the fully automatic level mode. In that mode the system maintains the level in the forming bins within 5 percent of the setpoint, which helps to improve forming line mat consistency. This mode also dramatically reduces frequency of equipment shutdowns due to inadvertent overfilling or emptying of the forming bins. Overall line down time is reduced and the amount of off-spec is minimized. ■

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