On-line measurement of dryer performance

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Conditions in the dryer section often prevent the practical papermaker from easily investigating problems. There just aren't many simple, quick, and effective ways to know whether the dryer section is doing its job—bringing a cool, wet sheet to temperatures where evaporation and drying will occur. Established methods of tracking performance include contact testing of the dryer surface temperature, incorporating a contact pyrometer, and the TAPPI TIS-0404-03 method for determining condensation rate.

Many mills also use an infrared (IR) gun to "shoot" the temperatures of the dryer surface to discover cold dryers. But this method can only detect cans that are almost fully flooded. Condensate layer thickness—as little as 1/16 in.—which affects dryer performance, cannot be seen. Also, the reflective nature of the dryer surface prohibits accurate readings without elaborate measurement of background and reflected radiation. A much better method of documenting the effective behavior of a dryer is to measure the temperature of the sheet after it exits the dryer.

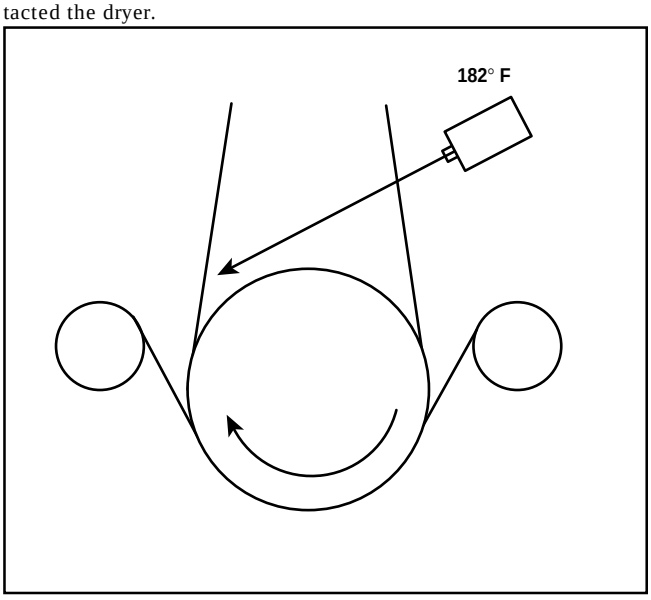
This shop talk explains how to track the on-line performance of individual dryers without extra labor or discomfort to those performing the tests.

Method

The method described here—on-line measurement of dryer performance—involves measuring sheet temperature with an infrared pyrometer (IR) as it leaves each dryer. The temperature of the sheet is measured and recorded approximately 6 in. after it leaves the dryer, on the side of the sheet which has just contacted the dryer, as shown in Fig. 1. Temperatures are recorded and charted for specific machine conditions. It is then possible to establish a database for specific grades and speeds, which will allow optimization of the drying process.

The IR gun used may or may not have an adjustable emissivity setting. Most technicians agree that between E = 0.92 and 0.95 is sufficient. It is imperative that the *same* setting be used, and that measurements be taken at the *same* point after the sheet leaves the dryer can. Several popular models of IR guns have laser pointers attached for improved aiming.

1. Temperature of sheet is measured and recorded approximately 6 in. after leaving the dryer, on the side of the sheet which has just contacted the dryer.



Theory/application

It is well documented that, within the dryer section, the sheet exhibits three distinct and separate zones of behavior:

- The sheet typically enters the dryer section at 95°F to 150°F, depending on conditions in the press and forming sections that modify stock temperature. The sheet then enters the *warm-up zone*, where it is heated with varying severity until it reaches evaporation temperature. Very little evaporation occurs in the *warm-up zone*, and condensing loads in individual dryers are very high.
- Once evaporation temperature is reached, the sheet enters the *constant rate zone*, where drying occurs at a steady rate. Evaporation temperatures vary by grade and basis weight, with newsprint and lighter-weight sheets beginning significant evaporation around 180°F. Heavier grades such as liner and bleached board enter the *constant rate zone* around 200°F. Sheet temperature will remain relatively constant on lighter-weight grades and will increase only slightly on heavier grades. Machines that use low vacuum rolls for sheet restraint and improved runnability have slightly lower

constant rate zone sheet temperatures than their unrestrained counterparts.

- When the sheet has reached its lower moisture levels—usually around 5%—the temperature begins to climb as the evaporation load and the condensing rate in the dryers decrease. The sheet is now in the *falling rate zone*. Less water is evaporated as the sheet passes consecutive dryers. If the sheet is allowed to remain at these elevated temperatures, drying capacity is lost—these dryers could be put to more efficient use in the constant rate zone. Such is the case of overdrying into a size press for moisture profile control.

Machines with size presses or coaters exhibit cooling to temperatures at or below the applied liquid temperature before entering the after-size section. Here, the sheet rapidly reaches a lower evaporation temperature, as most of the water is contained on the surface.

An example of on-line measurement of dryer performance as used on a fine paper machine is shown in Fig. 2. The sheet enters the dryers from the presses at 128°F. As the sheet passes through the first section, a unorun configuration, it is gradually heated by the top dryers but cooled by the bottom dryers. Ideally, the sheet reaches evaporation temperature while supported in the single-felted section, but in this case it doesn't. It reaches 180°F at Dryer 18 and remains at that level until Dryer 47, where the temperature begins to rise. The sheet reaches 250°F and remains there for three dryers before entering the size press. This represents significant overdrying into the size press. More significant is that three cold dryers are revealed by the cooler sheet—Dryers 11, 28, and 41.

With this method it is possible to track cold dryers, investigate sheet flutter, and more accurately plan maintenance requirements for outages.

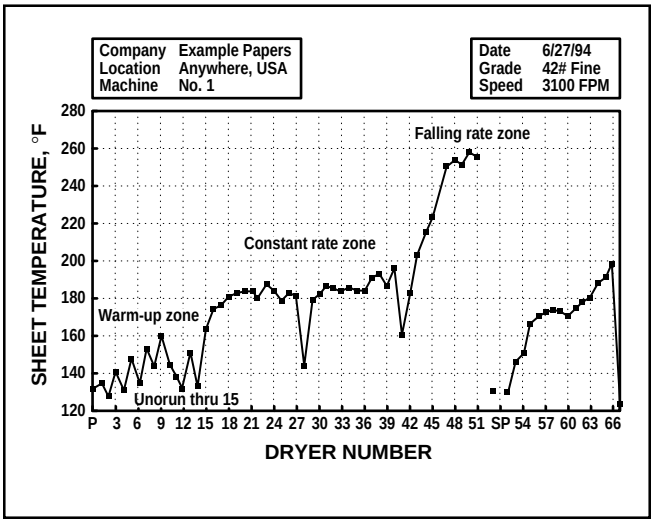
Case histories

On a supercalendering (SC) machine, drying was being lost and machine speed was suffering. Sheet temperature measurements indicated the sheet was cooler exiting from bottom dryers in the first double-felted section. Contact pyrometer readings showed that these dryers were hotter than normal, indicating very low condensing loads. The problem was found with the fabric stretch mechanism, which appeared fully loaded, yet was not. This caused the dryer fabric to slack off—losing firm contact with the dryer cans. The stretch was repaired and capacity was regained.

On a linerboard machine, sheet flutter was persistent on a dryer that had been internally inspected and appeared normal. The sheet was not being heated around the dryer, so the dryer was reinspected. The siphon was found to be set at the wrong clearance. Consequently, the dryer was running partially flooded.

A fine paper machine reported a loss of main-section capacity. Initial testing showed nothing abnormal. Sheet temperature tests showed a prolonged region of overdrying into the size press. Reference data on this grade showed this was abnormal. The problem? The moisture scanner that controlled drying had fallen out of calibration and the sheet was being dried to very low levels unintentionally. The scanner was recalibrated and capacity was regained.

2. Example of on-line measurement of dryer performance as used on a fine paper machine



Finer points of testing

- Ensure that the IR window does not fog during measurement, as false "cool" readings will result.
- Ensure that the readings are taken on the sheet and not on the surrounding machine.
- Ensure that readings are taken at the same point on the sheet in subsequent tests for comparative analysis, as the sheet cools significantly due to evaporation.

Summary

This simple, quick on-line measurement of dryer performance has proven very effective in detecting dryers not performing to expected levels. Cost of implementing on-line measurement of dryer performance is very low, as most mills already have an infrared pyrometer, and the cost of a new instrument is usually less than US$ 500. The method is quick and effective in identifying problem areas, defining the next course of testing, or both. It can also prevent the costly delay of waiting for an expert to arrive at the mill.

And finally, the collection of this data will help future troubleshooting, as a constant reference base of data is established. TP

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