TIP 0404-39

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Dryer surface temperature measurement

Scope

Dryer section performance has a major effect on paper machine productivity and sheet quality. Production rates are frequently limited by drying capacity, which is dependent on heat transfer from the steam in the dryers to the paper. To produce high rates of heat transfer to the sheet, high dryer surface temperatures are necessary. In order to achieve high quality, an even temperature is needed across the width of the dryers. Dryer surface temperature is therefore a critical parameter in evaluating dryer section performance. The information that follows summarizes techniques and procedures that are available for measuring dryer surface temperatures. Suggestions for interpreting the data are also included.

Introduction

The surface temperature of a dryer is a good indicator of performance. The difference between the temperature of the surface and the saturation temperature of supply steam is an indication of heat transfer efficiency from the steam, through condensate in the dryer, and through the cast iron dryer shell.

A survey of the dryer surface temperatures can reveal operating problems such as condensate buildup in dryers, incorrect syphon clearances, poor heat transfer due to variations in felt and sheet tensions, and roll alignment problems. Such surveys provide valuable information for planning shutdowns to maintain dryers at peak performance.

Safety precautions

Follow normal safety precautions when working around paper machinery. Do not allow loose clothing or equipment to contact rotating machinery or ropes. Take special care when utilizing contact pyrometers to measure dryer surface temperatures. Beware of thermal and slip hazards around the dryer section.

Discussion

Analysis of dryer performance

The temperature difference between steam and the dryer surface is the driving force for heat transfer from the steam, through the condensate layer inside the dryer and through the dryer shell to the surface. Similarly, the temperature difference between the dryer surface and the wet paper is the driving force for heat transfer from the dryer into the sheet. The equations that describe this heat transfer are:

$$q_1 = U_1 \times A_1 \times (T_s - T_d)$$
$$q_2 = U_2 \times A_2 \times (T_d - T_p)$$

This approach requires that the air next to the dryer be isolated from external air influences. These devices typically enclose a sensor with a low thermal mass, such as a fine wire thermocouple or an RTD element, in an insulated enclosure in contact with the dryer.

Contact pyrometers are generally made and used by experienced technicians. They are frequently used to conduct full CD temperature profile surveys. Special equipment is needed to safely hold the devices in place on the dryer and to traverse them across the machine width to obtain a CD profile.

One instrument of this type has a Teflon carriage that slides directly on the dryer surface. A similar unit uses a thermistor sensor to measure the boundary layer air temperature and has the sensor mounted in a carriage with rollers. Most units of this type that are commercially available have slow responses and are fragile. As a result, they have not proved to be popular for measurement of dryer surface temperatures.

B. **Infrared pyrometers**. The only truly non-contact temperature measurement system is the infrared pyrometer. The infrared radiation from the dryer surface is detected by an infrared sensor. The instrument uses the signal to compute surface temperature. Emissivity properties of the surface are entered as an input to the instrument.

The most common types of infrared sensors are hand-held guns. The sensor is simply aimed at the surface to be measured and temperature is automatically displayed.

Infrared sensors have the distinct advantage of not having to contact the dryer surface. Only a direct unobstructed view of the surface is needed. However, one of the primary disadvantages is the variable emissivity of dryer surface. Errors of up to 50°C in surface temperatures can result from variations in the dryer surface emissivity. Also, some gun types read a "cone" and are not a small area, unless the unit is close to the dryer surface.

Infrared techniques can provide accurate temperature measurements in some situations and erroneous readings in others. Since the emissivity must be entered for each dryer, the emissivity must be relatively constant if the indicated temperature profile is to be accurate. The typical dryer with a shiny surface, however, has a low emissivity that can change drastically with a buildup of pulp, coating, or filler on the surface. Reflectance of lighting from shiny surfaces is also detected by infrared instruments, producing false readings.

Inaccurate readings can also occur when dryer pockets have high humidities. When steam vapor is present, dryer pockets are not optically clear and infrared sensors measure temperature of the condensing steam vapor, which is at a lower temperature than the dryer surface. A cool infrared instrument, brought close to a dryer with a high humidity pocket, can have condensation on its lens and will report condensation temperatures instead of the dryer surface, which it can no longer "see."

Despite these sources of error, hand-held infrared guns have proven useful to quickly identify dryers that have filled with condensate by measuring temperature of dryer heads and/or the sheet. High humidity and emissivity variations are not significant variables for heads and a dryer head with low temperature is an indication of a fully waterlogged dryer. However, a dryer that is filling with condensate but not yet completely filled may not yet have a cool head. Note that emissivity variations can produce false temperature readings if heads are painted or severely stained with lubricant.

Situations in which infrared techniques have been successfully used include paper machines in which the dryers have uniform surface conditions and the pockets have good optical clarity.

Infrared thermography

Infrared thermography is a technology frequently used to monitor large areas for hot spots such as in electrical control panels and switchgear. These systems use infrared cameras to display entire viewed images as pictures in

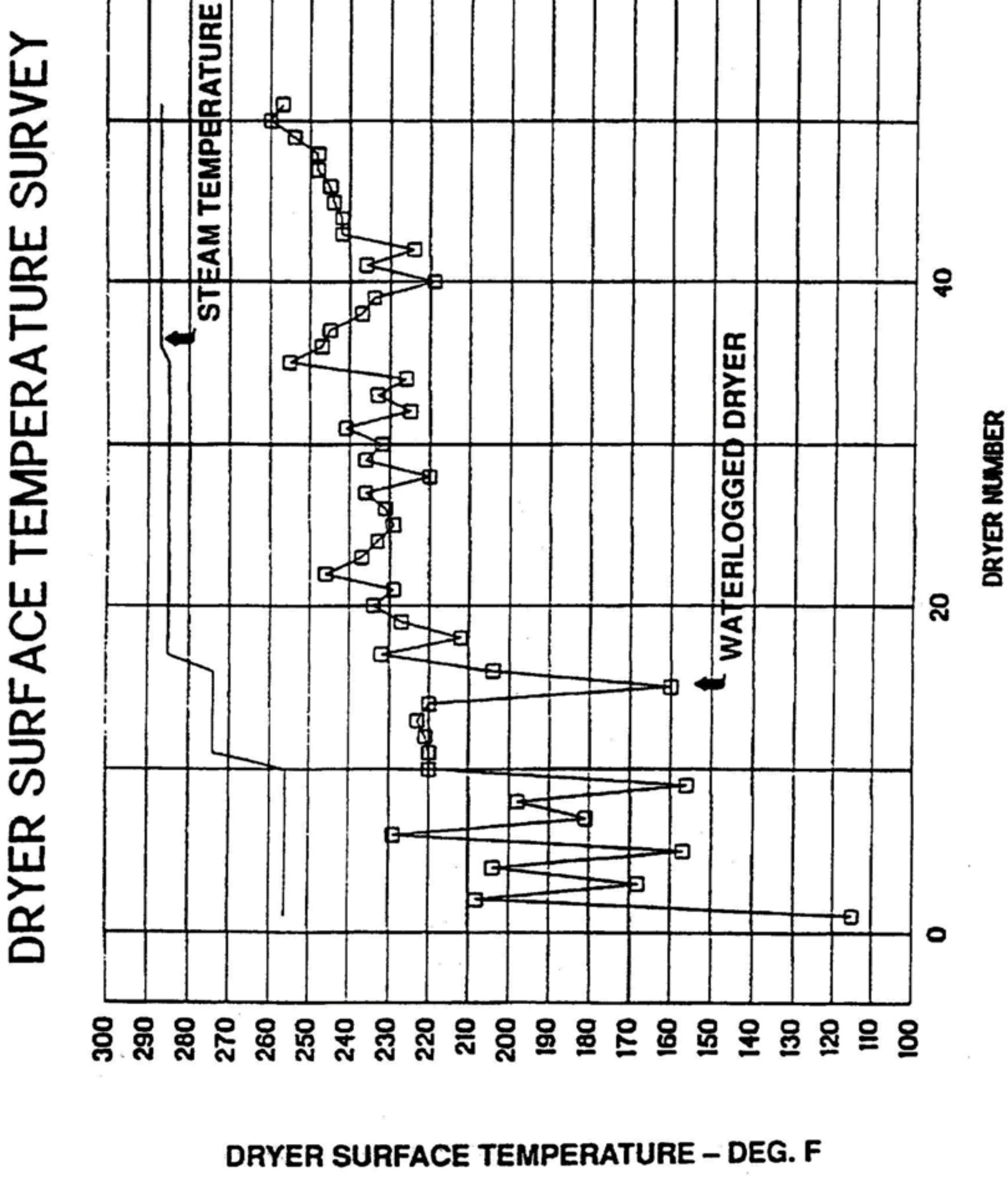

Fig. 1. Graphical display of dryer temperature survey results

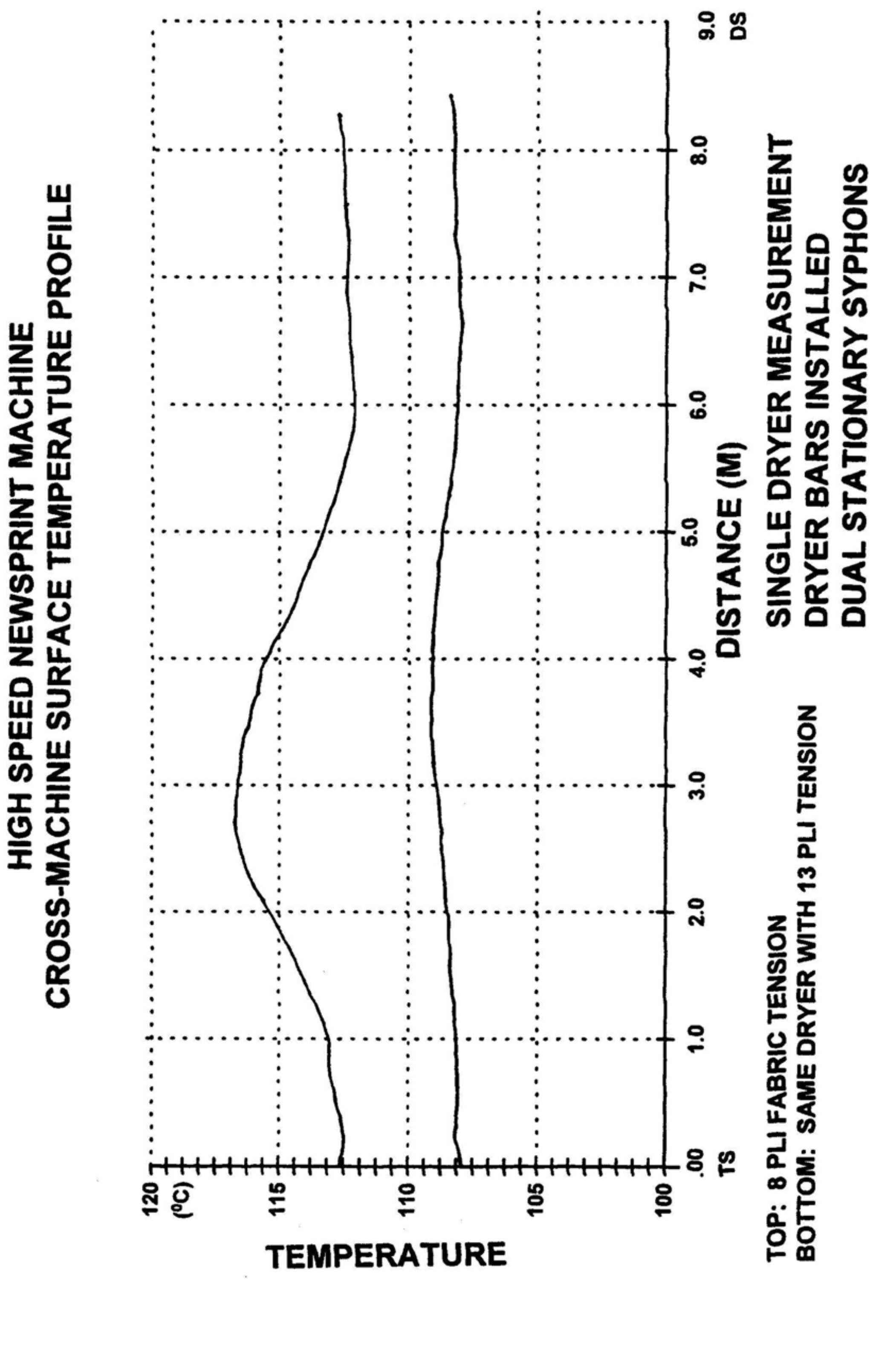
HIGH SPEED NEWSPRINT MACHINE
CROSS-MACHINE SURFACE TEMPERATURE PROFILE
TEMPERATURE
120
(ºC)
115
110
105
100
.00
TS
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
DS
DISTANCE (M)
TOP: 8 PLI FABRIC TENSION
BOTTOM: SAME DRYER WITH 13 PLI TENSION
SINGLE DRYER MEASUREMENT
DRYER BARS INSTALLED
DUAL STATIONARY SYPHONS

Figure 7