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Recommended minimum dryer pocket air requirements

Scope

This Technical Information Paper (TIP) provides instructions for calculating the theoretical air volume requirements to achieve recommended average pocket humidity in two-tier dryer sections with conventional top and bottom dryer fabrics.

Safety precautions

This TIP covers an airflow calculation. There are no safety precautions that apply to this TIP.

Requirements

Pocket ventilation involves the introduction of hot, dry air into a dryer pocket, using an air distributing roll or a cross-machine duct commonly referred to as a pocket ventilator. This ventilation results in a simple mixing process of the supply air that is introduced into the pocket and the water vapor leaving the sheet in the open draws between dryers. This mixing process is represented by the following mass balance equations:

$$(Q_s / V_s) (H_s) + R (\pi D) = (Q_s / V_s) (H_m) \quad (1)$$

or

$$Q_s = R (\pi D) V_s / (H_m - H_s) \quad (2)$$

where:

- Q_s = Air volume introduced into pocket, (ft³/min)/ft of dryer width [(m³/min)/m of dryer width]
- H_m = Absolute humidity of mixture, lb of water/lb of dry air [kg of water/kg of dry air]
- D = Dryer diameter, ft [m]
- R = Evaporation rate, lb of water/min·ft² total dryer surface [kg of water/min·m² total dryer surface]
- H_s = Supply air absolute humidity, lb of water/lb of dry air [kg of water/kg of dry air]
- V_s = Supply air specific volume, ft³/lb of dry air [m³/kg of dry air]
- π = 3.1416

Note that if the evaporation rate (R) represents the average evaporation rate for the dryer section, as calculated using TIP 0404-07, then the calculated supply air volume represents the average flow rate for each dryer.

If, on the other hand, the evaporation rate (R) represents the evaporation rate for a specific dryer, then the calculated supply air volume represents the flow rate for that specific dryer. The evaporation rate for one dryer may be considerably different from the average rate for the dryer section, depending on location of the dryer in the dryer section, steam pressure in the dryer, dryer fabric tension, etc. The local evaporation rate is typically calculated from detailed drying models. This is beyond the scope of this Technical Information Paper.

The recommended volume of air that should be introduced into a dryer pocket for effective pocket ventilation and drying are shown in Table 1 for various evaporation rates and dryer diameters. These values theoretically achieve the target humidity for the listed operating conditions. The volume of air that must be supplied to the pocket-ventilating device may be higher than these values, because not all of the air that is supplied to the ventilator goes into the dryer pocket. The amount of air that goes into the pocket depends on the ventilator type, location, degree of leakage, machine speed, and fabric permeability. Note that the target humidity levels increase as the drying rate increases. This reflects the humidity values that are achieved on papermaking machines with well-ventilated dryer pockets. These levels are listed in the tables below.

Note: The dryer section hood must be operated in accordance with the recommendations outlined in TIP 0404-24 "Recommended Operation of Dryer Section Hood Air System." for pocket ventilation systems to operate properly. The recommendations in this TIP relate only to ventilation of dryer pockets, not to an entire dryer hood.

These calculations are based on supply air temperature of 200°F (93°C). Note that air flow requirements are based on mass of air introduced into the pocket. Since air at higher temperature has higher specific volume, increasing supply air temperature requires additional volume (cfm or m³/min) of supply air. Recommended supply air temperatures are 180 to 200°F (82 to 93°C).

Actual acceptable air flows are often a compromise between those recommended to achieve target pocket humidity and limitations to sheet stability, particularly in dryer sections near the wet end of the paper machine. Excessive amounts of air introduced to dryer pockets can cause sheet flutter and runnability problems.

Table 1. Recommended minimum air volumes.

Dryer pocket air supply volume, ft³/min per foot of dryer width

Evaporation Rate lb/hr-ft ²	Target Pocket Humidity	Dryer Diameter			
		4 ft	5 ft	6 ft	7 ft
1.00	0.120	35	44	53	62
2.00	0.165	49	61	73	85
3.00	0.200	59	73	88	103
4.00	0.230	67	84	101	117
5.00	0.255	75	94	112	131
6.00	0.275	83	104	124	145
7.00	0.290	91	114	137	160
8.00	0.300	101	126	151	176

Supply air = 0.02 lb-water/lb-dry air at 200°F dry bulb (108°F wet bulb)