TIP 0404-05

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Methods of evaluating high velocity dryers

Scope

The purpose of this TIP is to provide guidelines to evaluate the performance of high velocity air impingement dryers used in the manufacture of paper products.

Significance

High velocity air impingement dryers are used throughout the paper industry and have numerous applications. The drying of coating on paper is one application. High velocity dryers are also used to dry tissue and machine glazed (MG) papers in conjunction with a steam heated (Yankee) cylinder.

High velocity air impingement dryers transfer heat to the web by convection and to a lesser degree, radiation.

High velocity air impingement dryers can be broken down into two types: those with and those without external heat addition. An example of a hood without external heat addition is a coating dryer where the air impinges onto the paper web with no other heat source under the hood covered part of the web. An example of a hood with external heat addition would be a Yankee hood with a Yankee cylinder.

Safety Precaution

Some of the measurements required for the tests described in this document may expose the person(s) carrying out the work to personal discomfort or the risks of burns due to high ambient temperatures. In addition, risk of injury due to proximity to rotating machinery exists. The measurements described herein should be carried out with due care.

Description

A typical high velocity dryer system consists of a hood (Yankee hood for example) that encloses a system of supply air distribution nozzles. The surface of the dryer facing the paper consists of an array of nozzles or slots for blowing hot air onto the paper. Return air slots or tubes are provided to allow the moist spent air to flow back to a suction plenum in the hood.

The air system consists of a supply fan, air heater (usually equipped with an oil or gas burner), and ductwork. The air system is used to heat the air to the necessary temperatures and increase its pressure to achieve the desired impingement velocities. An exhaust fan is provided to remove a part of the circulating air and the water vapor. Fresh air is introduced into the circulation system to replace the exhausted air. In order to improve economy, the fresh "make-up" air and the combustion air are often pre-heated in a heat exchanger thereby recovering a part of the heat in the exhaust air. A typical hood system is shown in Figure 1.

$$Net\ Nozzle\ Area = (Nozzle\ Covered\ Area) \times (PerforationFraction) \quad (4)$$

$$V_n = \sqrt{2P_n / \rho} \quad (5)$$

$$M_{Smix} = V_n \times Net\ Nozzle\ Area \times \rho \quad (6)$$

$$M_{S\ dryair} = M_{Smix} / \left(1 + X_S\right) \quad (7)$$

The humidity and density of the air can be determined with the aid of psychometric charts or tables given the dry bulb and wet bulb temperatures at both the supply and return air,

* Discharge coefficients, C_d for different types of nozzle are found in Figure 2.

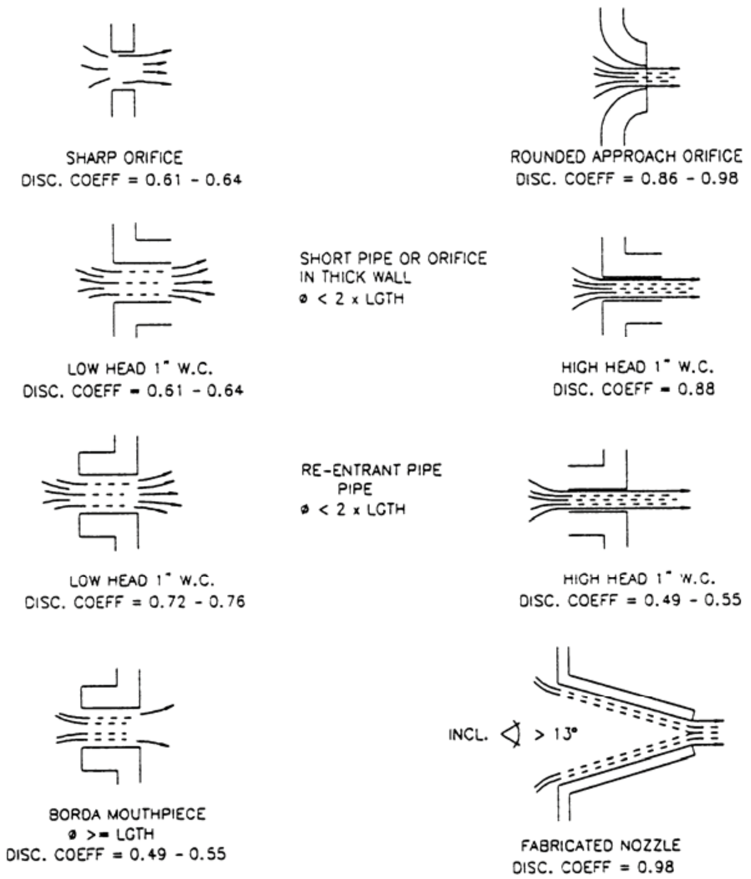

FIGURE 2 - Nozzle & Orifice Discharge Coefficients

NOTE 2: This method requires that the hood be balanced or in a slight over-pressure condition (spilling) to avoid infiltration of fresh air into the hood (where the paper enters and exits and around the sides), so as to not affect the humidity of the return air. The flow rate of the return air may also be measured to check the system balance.