to a minimum. A factor often overlooked is that of suitable provision for ventilation of the space around the dryer openings so that warm moist air which may escape from the dryer when the doors are opened may be carried away before it has a chance to condense on the ceiling or windows of the building in which the dryer is located or into which it opens. Convenient arrangements for the operator should also be provided where tests can be made, records kept, and clothes changed, in case it is necessary for the operator to work inside the dryer.

EXPERIMENTAL TECHNIQUE

One vitally important phase of dryer design has been ignored in the preceding discussion, namely, *the time required to dry the stock*, or, what is equivalent to the same thing, *the size of the dryer*, and the character and extent of the *contact surface* between the stock and the air. In general, this cannot be determined except on the basis of experimental data on the specific material to be dried. The source of such data may either be the known performance of actual commercial drying installations handling the same stock or direct experimental determinations in the laboratory. Data of this type for many materials are given in Table 8.

Where it is necessary to determine drying conditions and rate in the laboratory, it is vitally important properly to control the experimental conditions. Where possible, the material upon which the experiments are made should have the same shape and size as that to be treated commercially. Furthermore, the conditions of exposure to the drying air, the temperature and humidity of that air, and its velocity and distribution over the material should be identical with those used in the full-scale operation. Where the commercial operation is by batch, it is relatively easy to duplicate commercial conditions in the laboratory.

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Chapter 31

DUCTS, GRILLES, AND REGISTERS

Resistance to Flow; Static, Velocity, and Total Pressures; Fundamentals of Duct Design; Friction Losses; Methods of Distribution; Grilles and Registers; Measurement of Air Flow.

THE laws governing the flow of all fluids are based on the assumption that the density remains constant throughout the flow. In considering the flow of a gas such as air, however, the laws referred to do not strictly hold. The velocity in an air duct of uniform size varies due to a loss or decrease in pressure which causes an increase in volume and a consequent increase in the velocity.

The flow of air due to a large difference in pressure is most accurately stated by thermodynamic formulae for air discharge under conditions of adiabatic flow. The flow of air in heating and ventilating ducts takes place under very small pressure differences, usually less than a pressure equivalent of 2 in. of water. Under this condition the change in density is very slight and for all practical purposes of calculation and design the density may be assumed constant and the laws governing the flow of fluids applied.

For ordinary duct work where flow exists under a low pressure difference but slight error is introduced if the same formulae are applied to the flow of air as are commonly used for the flow of water. The basic formula for such calculation is:

$$V = 1096.5\sqrt{\frac{p}{W}} \tag{1}$$

where

V = velocity in feet per minute.
p = head or pressure in inches of water.
W = weight of air in pounds per cubic foot.

For standard air (70 F, and 29.92 barometer) W = 0.07495 lb per cubic foot. Substituting this value in equation (1)

$$V = 1096.5\sqrt{\frac{p}{0.07095}} = 4005\sqrt{p} \tag{2}$$

An inspection of Formula 1 indicates that temperature affects the velocity of flow by changing the weight per cubic foot of air. Tables 3 and 4 (Chapter 2) give the velocity at various pressures and temperatures.

RESISTANCE TO FLOW

There are two types of loss that occur when air moves in a confined space. One is the frictional resistance of the air with the walls of the