METHODS OF SIMULATING VENTILATION SYSTEMS

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A refinement of simulation is shown for testing air ducts without geometrical similarity of surface roughness.

As is well known, the simulation of ventilating ducts requires that both geometrical and dynamic similarity criteria be observed. A rigorous geometrical similarity requires, for simulating the roughness of the original, a certain amount of surface polish on the inside walls of air ducts. The dimension of these nonuniformities becomes then so small, when it comes to recalculations for the model design, that reproducing them under laboratory conditions is fraught with difficulties; furthermore, a surface polish changes the shape parameters of roughness.

If the requirements of accurate geometrical simulation are eased, then it becomes necessary to correct any errors which occur inasmuch as the hydraulic drag coefficient is a function of roughness. This correction can be made by adjusting the length of the duct segments, on the basis of the following considerations.

The geometrical parameters of the model segments must be such as to satisfy the requirement that the ratio of friction head loss to velocity head be identical here as in the original. The ratio of these two physical quantities represents a similarity criterion which involves the product of a dimensionless length and the coefficient of hydraulic friction drag.

The length of the appropriate aerodynamic mode segment is then defined as

$$l_{\text{M}} = \frac{\lambda_{\text{o}} d_{\text{M}}}{\lambda_{\text{M}} d_{\text{o}}} l_{\text{o}} \tag{1}$$

Here the subcript M refers to the model and the subcript o refers to the original.

Expression (1) can be rewritten in a more general form:

$$\frac{c_{\lambda} c_l}{c_d} = 1. \tag{2}$$

Only with this relation between the design parameters of the original and the model satisfied, will it be possible to make the model more accurate and to avoid errors due to equal roughness in both.

NOTATION

- l is the length of air duct segment;
- d is the diameter;
- Δ is the roughness;
- λ is the coefficient of hydraulic friction drag;
- v is the mean air velocity;
- ν is the kinematic viscosity;
- t is the air temperature;
- P is the pressure;
- c_l is the length scale in model;
- c_d is the characteristic section (area) scale;
- c_{λ} is the scale of hydraulic friction drag.

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