Two types of mathematical models for gaps

Quadratic model

$$\Delta p = \zeta \frac{\rho}{2}\left(\frac{q}{wl}\right)^2 + 12\mu \frac{d}{w^2}\left(\frac{q}{wl}\right) \qquad (10)$$

Pressure loss by turbulence — Pressure loss by friction

Eq.(10) is derived by spatially integrating the Navier-Stokes equations of motion for air. (Hiroshi Homma, et al. ref.[116])

Coefficients of quadratic model

- ρ:Air density
- μ:Viscosity coefficient
- w: Gap width
- l:Gap length
- d:Gap depth
- ζ:Pressure loss coefficient

Power law model

$$\Delta p = \frac{\rho}{2}\left(\frac{q}{s}\right)^n \qquad (3)$$

Instead of the pressure loss coefficient, the equivalent area s works.

Since eq.(3) is an experimental approximating equation, it is difficult to describe the physical meaning of the exponent n.

Coefficients of power law model

- n:Exponent
- s:Simple equivalent gap area

Here defining w is the gap width, d is the depth and l is gap length, d/w^2 can be called gap depth coefficient and $w \cdot l$ equivalent gap area.

The composite coefficients D_1 , D_2 , D_n and n in the next equations can be estimated by the least squares with the measurements data of Δp (pressure difference) and q (air flow rate).

$$\Delta p = D_1 \cdot q + D_2 \cdot q^2 \qquad (9)$$

$$\Delta p = D_n \cdot q^n \qquad (2)$$

$$w \cdot l = \sqrt{\frac{\zeta \cdot \rho}{2 \cdot D_2}} \qquad (11)$$

$$\frac{d}{w^2} = \frac{D_1}{12\mu}\sqrt{\frac{\zeta \cdot \rho}{2 \cdot D_2}} \qquad (12)$$

$$s = \left(\frac{\rho}{2 \cdot D_n}\right)^{\frac{1}{n}} \qquad (13)$$

The first term in eq. (9) is the pressure loss by the friction and the second term pressure loss is by the turbulance. Therefore, eq. (2) must express the friction loss by the gap opening area that is much smaller than the actual area. This is one of the drawbacks of the model (2).