November 12, 13, 14, 2003

23-2　Model Country – Workshop on Energy Conservation Policies Planning

ワークショップ

Method of calculating test results

○ Air density (ρ)

$\rho = 1.293 \times 273 / (273+t) \times p / 760$

1.293 : Value at air density of 0 ℃ 760 mmHg
273 : Temperature in Kelvin (K)
t : Measured ambient temperature (℃)
p : Atmospheric pressure in the test room (mmHg)
760 : Atmospheric pressure at standard condition (mmHg)

○ T (To be used in calculating the volume of air)

Volume of air Q= 60×A×v

A : Cross-sectional area of tube (m^2)
v : Velocity of flow of air (m/s)
$\underline{v=\sqrt{(2\times g\times \rho)} \times\sqrt{Pd}}$
g : Acceleration of gravity 9.80665 m/s^2
p : Air density kg/m^3
Pd : Dynamic pressure mmAq

by substituting the v formula into v,

$Q = \underline{\underline{60\times A\times \sqrt{(2\times g\times \rho)}}} \times\sqrt{Pd}$

by taking the double-underlined area as T,

$Q = T\times\sqrt{Pd}$

From this test results of the pipe resistance, the pipe 100 A (inside diameter: 105.3 mm) will have the following T value:

$\rho = 1.293\times 273 / (273+35) \times 764 / 760 = 1.1521$

$T = 60\times(105.3^2\times 1000^{-2}\times \pi / 4) \times\sqrt{(2\times 9.80665 / 1.1521)} = 2.1559$

○ Temperature conversion factor K

Values should be converted into those at the standard condition of 760 mmHg (1013 hPa) 20 ℃

$K = (273+t) / (273+20) \times 760 / p$

Multiply by this K value to convert values into those at the standard condition.

Drawing a performance curve

The air quantity Q in m^3/min, the shaft output L in kW, and blowing output La in kW and the efficiency η in percent are given by:

$$Q = 60 \times A \times v$$

$$L = \left(\frac{I}{I_0}\right) \times L_0$$

$$L_a = \frac{P_1 \times Q}{6120}$$

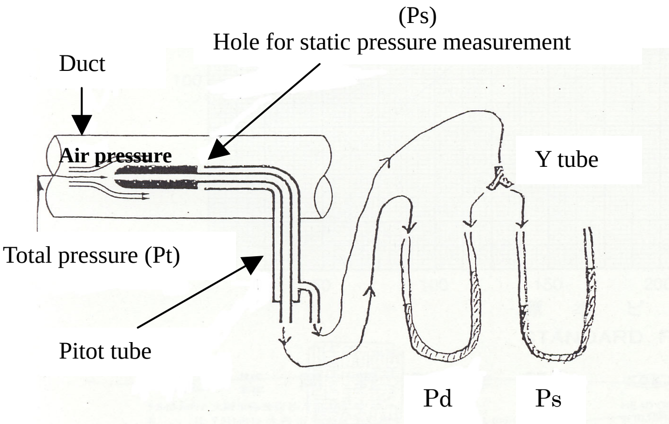
$$\eta = \left(\frac{L_a}{L}\right) \times 100$$

> Measurement of volume of air using a Pitot tube
>
> $$v = c\sqrt{\frac{2g \bullet Pd}{p}}$$
>
> C = Average correction factor (PITOT COEFFICIENT)
>
> With the Pitot tube used in this training,
> C = 1 (refer to the attached documents)

where

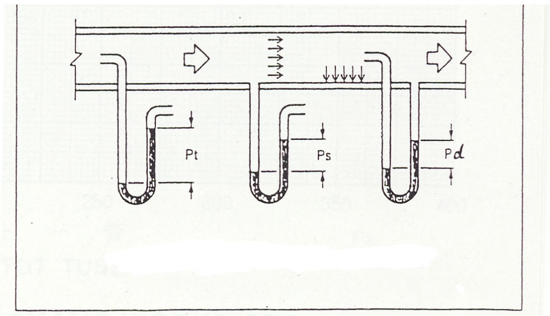
A= sectional area of the duct m^2
v= flow velocity in m/s, given by
$v = \sqrt{(2 \times g / \rho)} \times \sqrt{Pd}$
g= gravitational constant 9.80665 m/s^2
ρ = specific weight of air　kg/m^3
I = current consumption of the motor　A
I_0 = rated current of the motor　A
L_0 = motor power　kW
Pt = total pressure　(Ps+Pd) mmAq
Ps = static pressure　mmAp
Pd = dynamic pressure　mmAp
The conversion rate of 1 mmAp = 9.80665 Pa is applicable.

The performance curve is drawn on the basis of these parameters



Pd (dinamic pressure) =
Pt (total pressure) - Ps (static pressure)

Illustrated explanation of total, static, and dynamic pressures

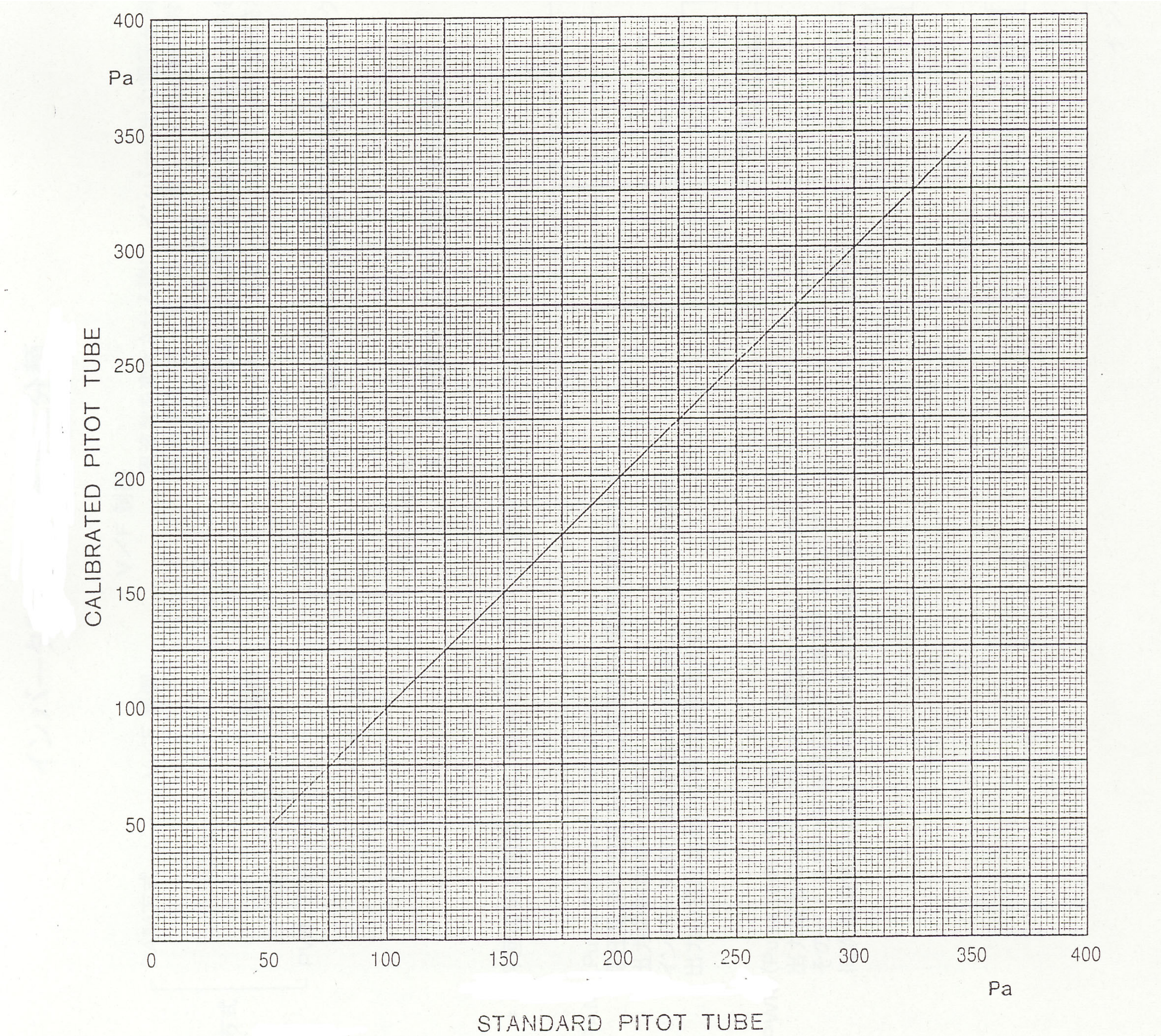


Pt (total pressure) =
Ps (static pressure) + Pd (dynamic pressure)

Pitot Tube Test Inspection

Product	JIS Type	**Date**	May 13, 2003		
Type	LK-3	**Atmospheric Pressure**	1 atm		
Product. No	32M183	**Temperature**	22℃	**Humidity**	72％
Pitot Coefficient	C=1.00	**Kind of Gas**	Air		

Pitot coefficients between 0.99 and 1.01 are indicated as 1.



General classification of inverter control

Method of inverter control
- PAM method — V/F control
- PWM method
  - V/F control
  - Vector control
    - Current vector
    - Voltage vector

V/F control

Method of keeping the motor magnetic flux by controlling the inverter output voltage while changing the frequency to prevent decrease in the efficiency and power factor of the motor against a wide range of adjustable-speed operation.
This method is a simpler and has a long history as an inverter control method, which is widely applied to energy-saving drive system of fans or pumps.

Current vector

This method controls directly the motor magnetic flux, current generating torque, or torque current.

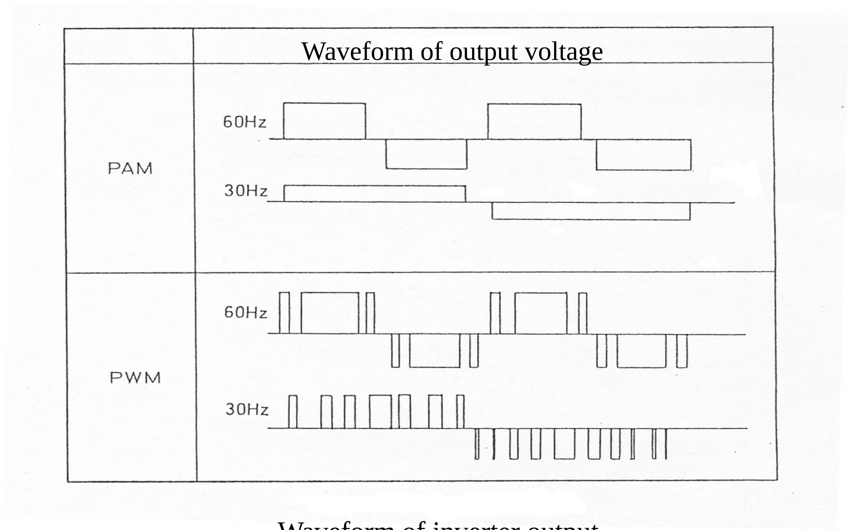
Voltage vector

This method controls the motor magnetic flux or torque through the voltage.

＊ The training equipment this time adopted PWM method → V/F control.

◎ PAM (Pulse Amplitude Modulation)
Method of controlling outputs by changing amplitude of the voltage or current of the power.
The inverter controls only frequency, and the converter does only output voltage or the current.

◎ PWM (Pulse Width Modulation)
Method of achieving a smooth output with less low level of high-frequency by generating many trains of pulses during the half-cycle of the output waveform to change the equivalent voltages of the pulse width into a sign wave.



Waveform of inverter output