

FAN AND BLOWER**JGS 210-120-1-68E**

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CONTENTS

	<u>PAGE</u>
1. SCOPE	2
2. WORK PROCEDURE	2
2.1 Input to the Design	2
2.1.1 Process Conditions	2
2.1.2 Input Data	2
2.2 Output from the Design	2
3. DESIGN	3
3.1 General	3
3.2 Type Selection Flow	3
3.3 Procedure	3
3.4 Design Procedure	3
3.4.1 Determination of Suction Conditions	3
3.4.2 Determination of Discharge Conditions	4
3.4.3 Shaft Power	5
3.4.4 Sizing of Driver	5
3.4.5 Driver Rating	5
3.4.6 Operation Controls	5
3.4.7 Fan Lows	6
Fig. 3.1 General Areas of Fan and Blower Application	7
Fig. 3.2 Fan and Blower Selection Flow	8
Fig. 3.4.6 Operation Control Scheme	9
Table 3.4.2 Efficiency of Fan and Blower	10
Table 3.4.4 Power Coefficient	10
Table 3.4.5 Motor Rating (KW)	10
4. ABBREVIATION	11
5. REFERENCES	11

1. SCOPE

This standard practice defines the procedure for the selection of Fan and Blowers for the basic design engineering of process plants.

2. WORK PROCEDURE

2.1 Input to the Design

2.1.1 Process Conditions

(1) Source of the data

The design data will be obtained from, but not limited to, the following documents;

- Process Flow Diagram (PFD)
- Basic Engineering Design Data (BEDD)
- Piping & Instrument Diagram (P&ID)

2.1.2 Input Data

(1) Operating Conditions

The following is a summary of operating conditions data to be specified before the design.

- Service for identification
- Fluid name for identification
- Flow rate of handling gas (maximum, normal and minimum)
- Operating temperature (maximum, normal and minimum)
- Suction pressure (maximum and normal)
- Physical properties of handling gas
 - Density
 - Viscosity
 - Vapor pressure
 - Specific heat (if temperature rise at fans and blowers should be estimated.)
 - Corrosive tendency
 - Toxicity or flammability

(2) Performance Requirements

Following requirements should be clarified by hydraulic calculation and process requirements.

- Differential head
- Automatic start/stop for spare fan or blower (if necessary)

(3) Mechanical Design Data

Following data should be specified for selection of fans or blowers type.

- Code to be applied
- Material of construction (if specified from experience)
- Mechanical design temperature and pressure, if any.

2.2 Output from the Design

(1) Basic preparation of fans and blowers data sheet

- Preliminary selection of fans and blowers type
- estimation of hydraulic horsepower, brake horsepower and motor driver power
- The latest JGC standard forms (JGC FORM NO. 1819-1  and 1819-2 ) for fans and blowers shall be used to show necessary data.

(2) Follow-up work after design of fans and blowers by vendor

- Performance curve-check including surge limit pressure
- Incorporation of auxiliary piping to P&ID
- Incorporation of utility consumption to utility summary

3. DESIGN

3.1 General

Typical design procedure should be as follows ;

(1) Decide following inlet conditions :

- Temperature (°C)
- Pressure (mmAq)
- Specific heat ratio (–) or Specific heat C_p (kcal/kg°C)
- Density (kg/m³)

(2) Calculate the inlet volume (m³/min) from the fan and blower suction condition.

(3) Decide total discharge pressure (mmAq).

(4) Correct data, such as, nature of gas, corrosion, entrained solid particles and entrained moisture.

(5) Plot the inlet volume (m³/min) and pressure (mmAq) on Fig. 3.1.

(6) The following factors shall be considered for selection of fans and blowers.

- Environmental problem (noise, vibration etc.)
- Cost (Operating and investment)
- Easy construction

3.2 Type Selection Flow

Fans and blowers type shall be decided based on the process flow diagram.

The basic procedure is shown in Fig. 3.2.

3.3 Procedure

Section 3.4 of this practice gives the detailed procedures to prepare the data sheets and estimate the power consumptions.

3.4 Design Procedure

3.4.1 Determination of Suction Conditions

The following conditions for the suction flange of the fan and blower shall be determined.

(1) Temperature (°C)

(2) Pressure (mmAq)

(3) Humidity

$$V_w = V_d \left(\frac{P_s}{P_s - (P_v)(RH)} \right) \quad (\text{m}^3/\text{min}) \dots\dots\dots (3.4.1-a)$$

- where,
- | | | |
|-------|---|--|
| V_w | = | Wet gas volumetric flow rate (m ³ /min) |
| V_d | = | dry gas volume (m ³ /min) |
| P_s | = | inlet absolute pressure, (mmAq abs) (usually atmosphere) |
| P_v | = | Saturated vapor pressure at inlet temp, (mmAq abs) |
| RH | = | Relative humidity (fraction) |

(4) Flow rate

The maximum, minimum and normal flow rates shall be considered for type selection.

(5) Properties of gases

The properties of gases shall be described, such as , corrosion , entrained particles and entrained moisture.

(6) Fluctuation in conditions:

Since fluctuations in the inlet conditions will effect on the fan and blower performance, conceivable fluctuations shall be specified in the design conditions.

(7) Inlet gas density

$$\rho_v = \frac{MW \times P_s \times 273}{22.4 \times 10330 \times T_s \times Z} \quad (\text{kg/m}^3) \dots\dots\dots (3.4.1-b)$$

where, MW = Gas molecular weight
 P_s = Inlet pressure at the fan, absolute press, (mmAq abs)
 T_s = Inlet temperature, (°K)
 ρ_v = Inlet gas density, (kg/m³)
 Z = Compressibility

(8) Inlet volume

When flow rate (kg/hr) is given

$$Q = \frac{W}{\rho_v \times 60} \quad (\text{m}^3/\text{min}) \dots\dots\dots (3.4.1-c)$$

where, W = Gas flow rate, (kg/hr)
 ρ_v = Gas density, (kg/m³)
 Q = Gas volumetric flow rate, (m³/min)

When normal volumetric flow rate (Nm³/min) is given

$$Q = Q_{NTP} \times \frac{T_s}{273} \times \frac{10330}{P_s} \quad (\text{m}^3/\text{min}) \dots\dots\dots (3.4.1-d)$$

where, Q_{NTP} = Normal volumetric flow rate at 0°C, 1 atm, (Nm³/min)
 T_s = Inlet temperature, (°K)
 P_s = Inlet absolute pressure, (mmAq abs)

3.4.2 Determination of Discharge Conditions

(1) Discharge pressure

Discharge pressure shall be determined based on the process condition.

(2) Discharge temperature

Temperature rise as the gas passes through a fan and blower is calculated by following equation.

$$\Delta t = T_s \times \left[\left(\frac{P_d}{P_s} \right)^{\frac{n-1}{n}} - 1 \right] \quad (^\circ\text{C}) \dots\dots\dots (3.4.2-a)$$

$$\frac{n-1}{n} = \left(\frac{k-1}{k} \right) \times \left(\frac{1}{\eta} \right) \quad (-) \dots\dots\dots (3.4.2-b)$$

where, Δt = Temperature rise, (°C)
 T_s = Gas temperature at fan and blower inlet, absolute temp., (°K)
 P_d = Fan and blower outlet pressure (mmAq abs)
 P_s = Fan and blower inlet pressure (mmAq abs)
 k = Specific heats ratio, C_p/C_v
 $C_p/C_v = C_p/(C_p - 1.986/MW)$
 C_p : Constant pressure specific heat (Kcal/kg°C) at T_s
 MW : Molecular Weight
 η = Efficiency of fan and blower, fraction, See Table-3.4.2
 n = Polytropic coefficient