SANYO DENKI

Sanyo Denki America

Cooling Systems Division

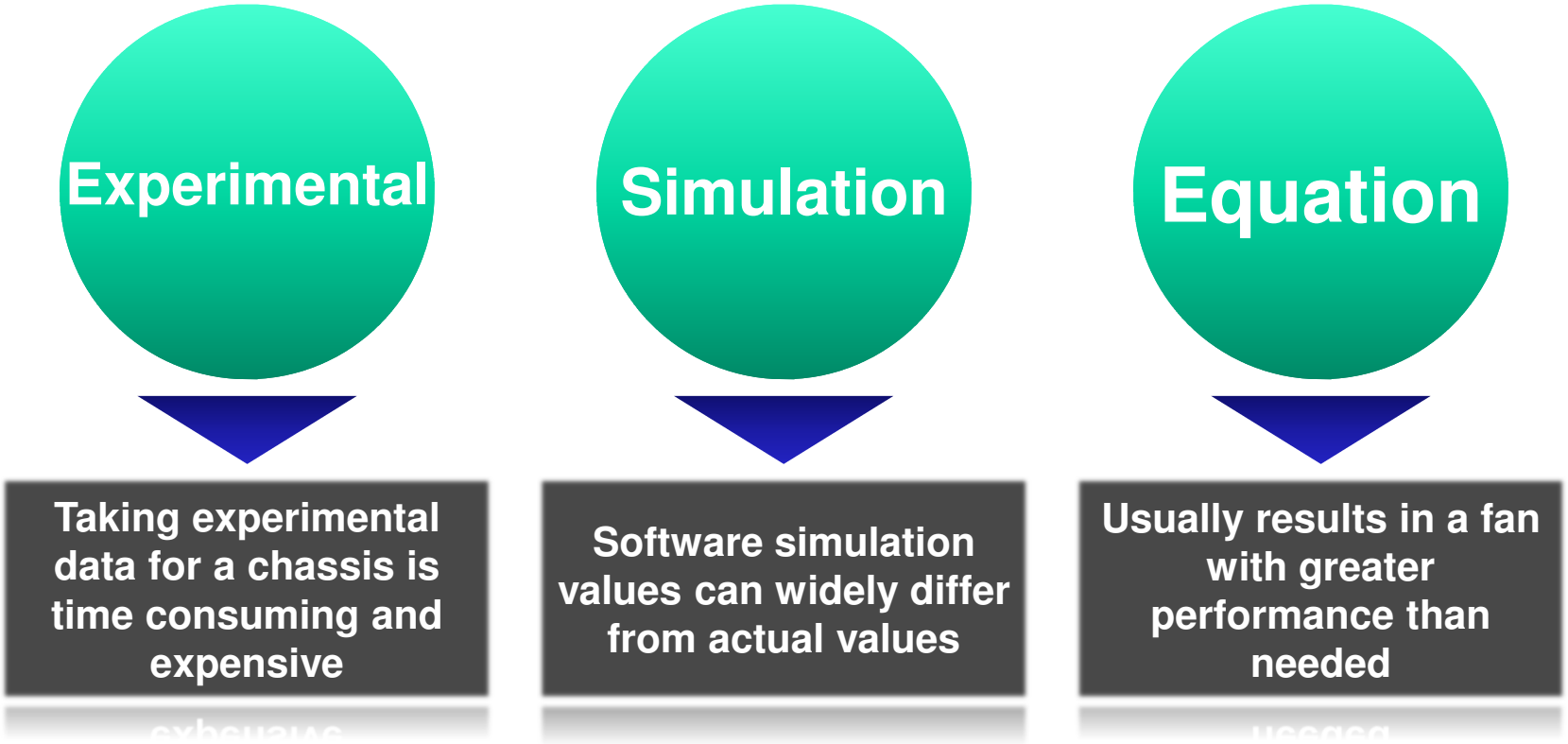
Understanding System Curves and Operating Points

Agenda

1. Challenges of fan selection
2. Operating fans in chassis
3. Optimizing Noise and Power Consumption
4. Identifying the best system operating point

1. Challenges During Fan Selection

Selecting a suitable fan for a chassis can be carried out by the 3 methods below.



1. Challenges During Fan Selection

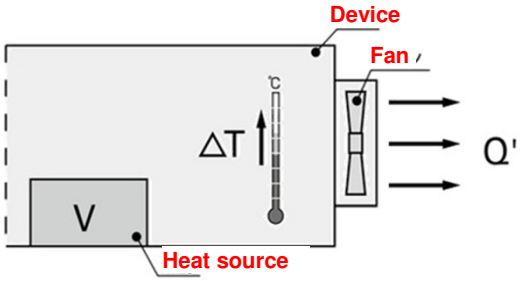
Equation

Calculate the required operating airflow to remove heat

Q': Required operating airflow (m^3/min)
V: Amount of heat generated within the device (W)
k: 20 (Constant = Specific gravity of air × specific heat
ΔT: Internal heat rise (K)

Ex.

Q': Required operating airflow
V: 100 (W)
k: 20 (Constant)
ΔT: 10 (K)



$$Q' = \frac{V}{k \times \Delta T} \Rightarrow \frac{100}{20 \times 10} = 0.5$$

Required operating airflow Q'=0.5 (m^3/min)

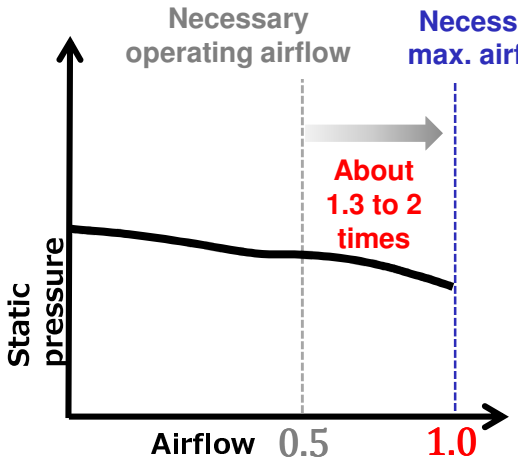
1. Challenges During Fan Selection

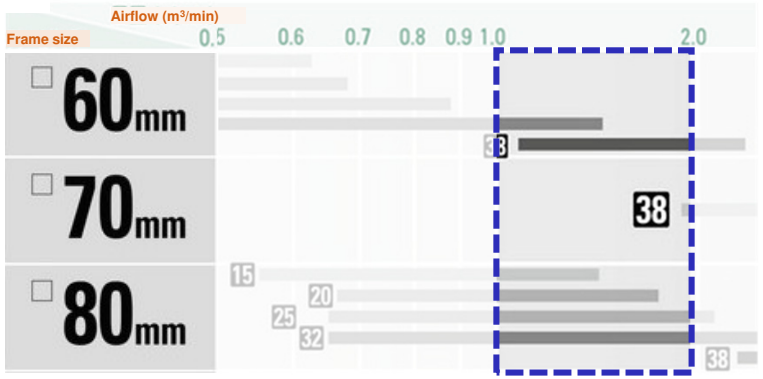
Equation

Select a fan by calculating the necessary maximum airflow

Necessary operating airflow Q' × safety margin of 1.3 to 2 times ≒ Necessary maximum airflow

Ex. $0.5 \times 2 = 1.0 \quad (m^3/min)$





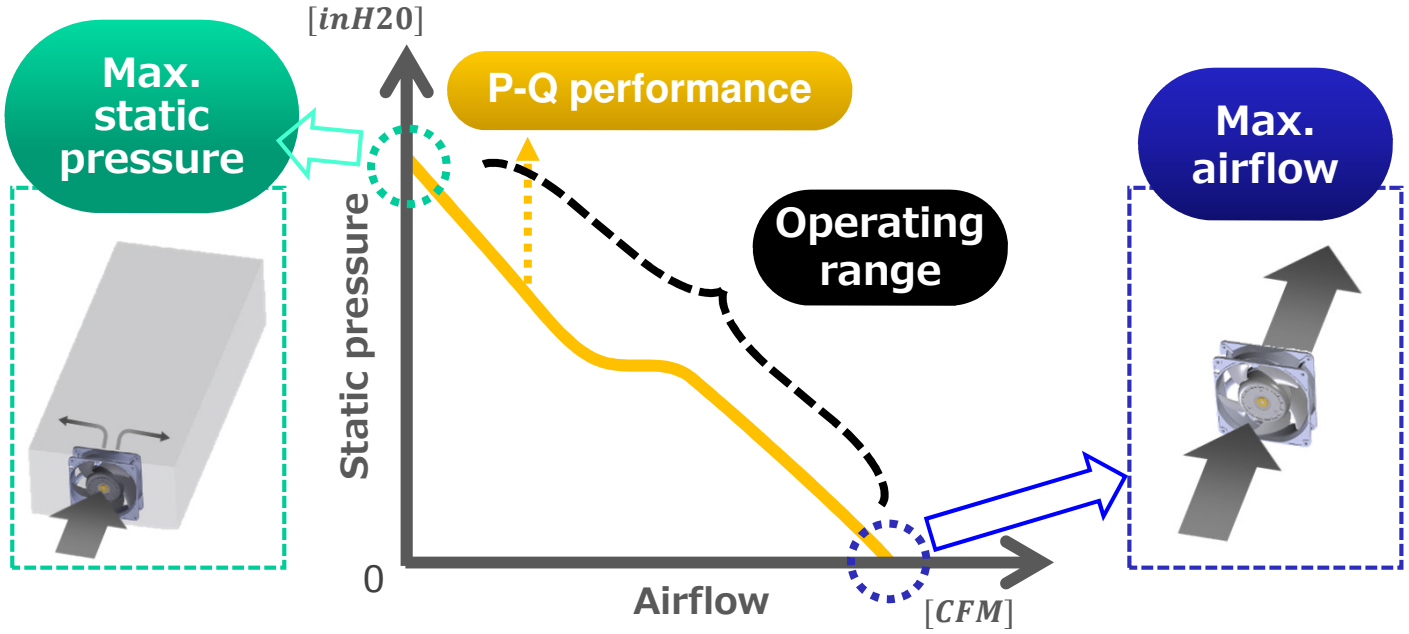
Using the equation results in a fan with more performance than required

2. Operating Fans in Chassis

Basic concept of a fan performance(P-Q) curve

Catalog excerpt

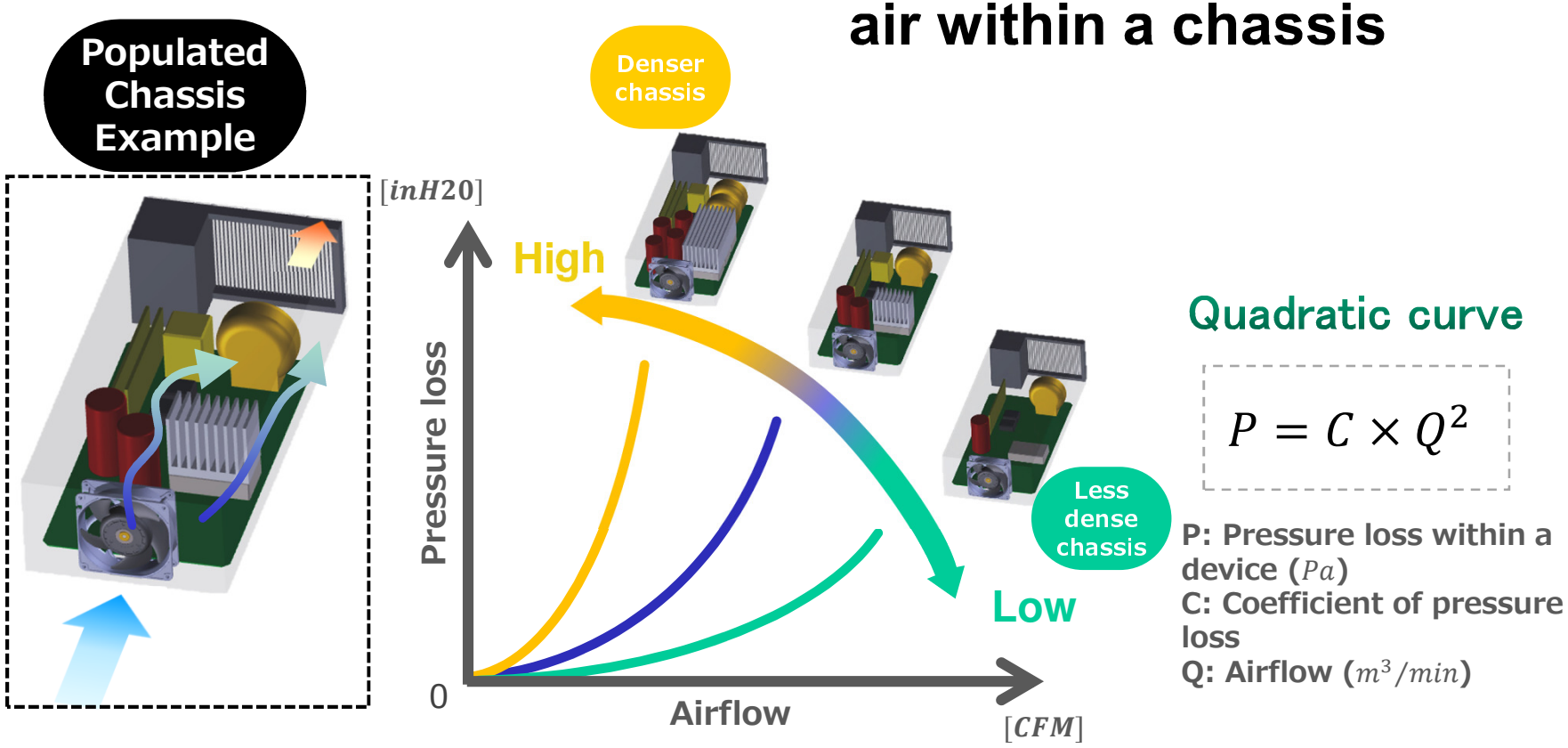
Model No.	Size	Rated Input $[W]$	Max. Airflow $[m^3/min]$	Max. Static Pressure $[Pa]$	SPL $[dB(A)]$
9GA0612G9001	60 × 10	3.24	0.62	66	43
9GA0612H9001	60 × 10	1.68	0.50	42.9	37
9GA0612L9001	60 × 10	0.36	0.23	9.1	17



2. Operating Fans in Chassis

Chassis ventilation resistance **= System impendence**

Resistance to the flow of air within a chassis



Quadratic curve

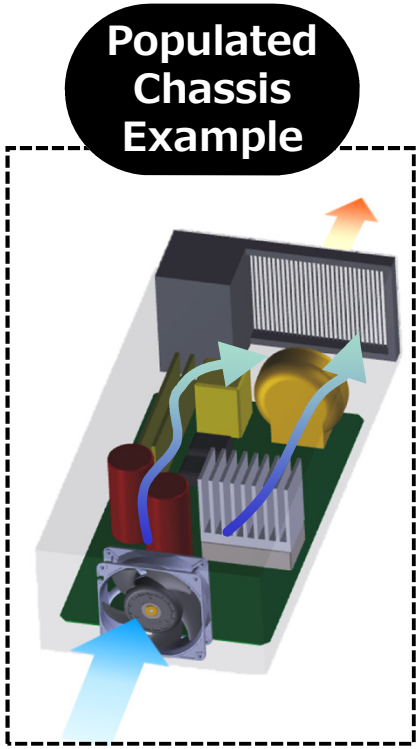
$$P = C \times Q^2$$

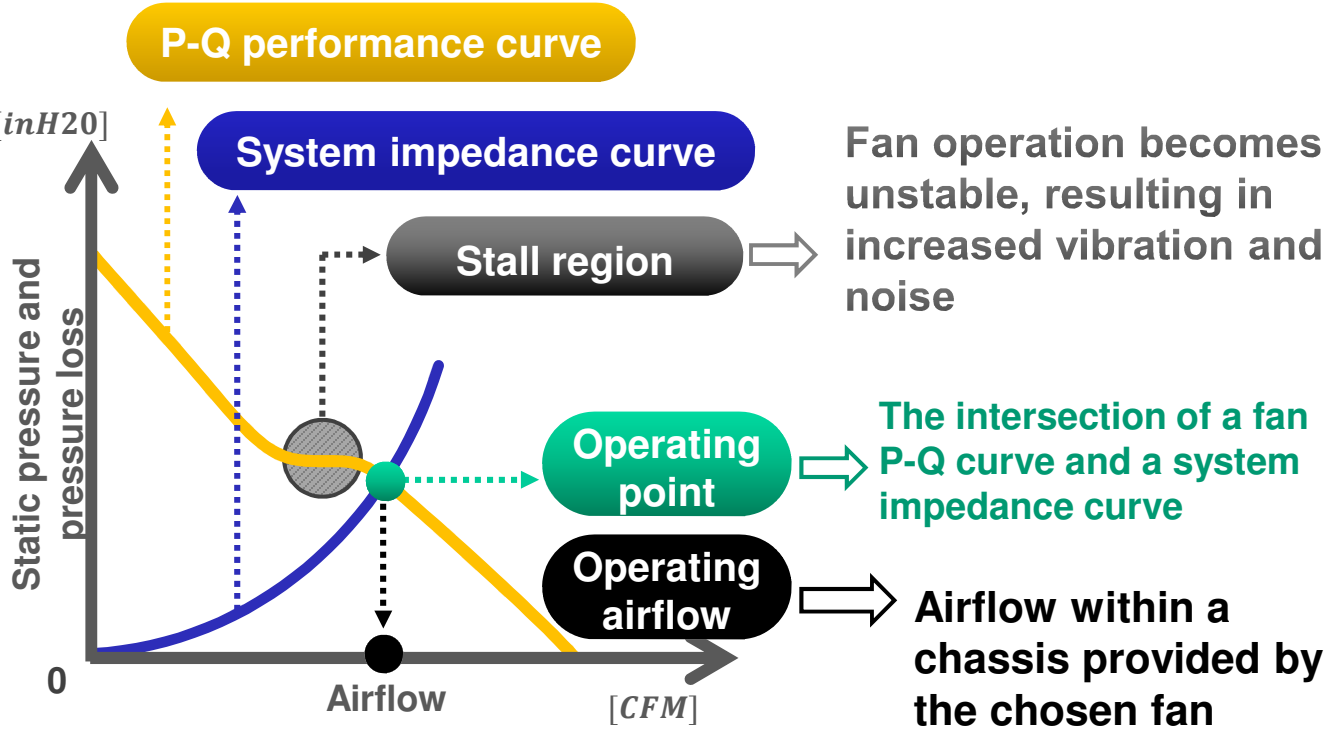
P: Pressure loss within a device (Pa)
C: Coefficient of pressure loss
Q: Airflow (m^3/min)

System impedance curves get steeper with denser chassis layout

2. Operating Fans in Chassis

Finding the operating point





3. Optimizing Noise and Power Consumption

Reducing noise

Catalog excerpt

Model No.	Size	Rated Input $[W]$	Max. Airflow $[m^3/min]$	Max. Static Pressure $[Pa]$	SPL $[dB(A)]$
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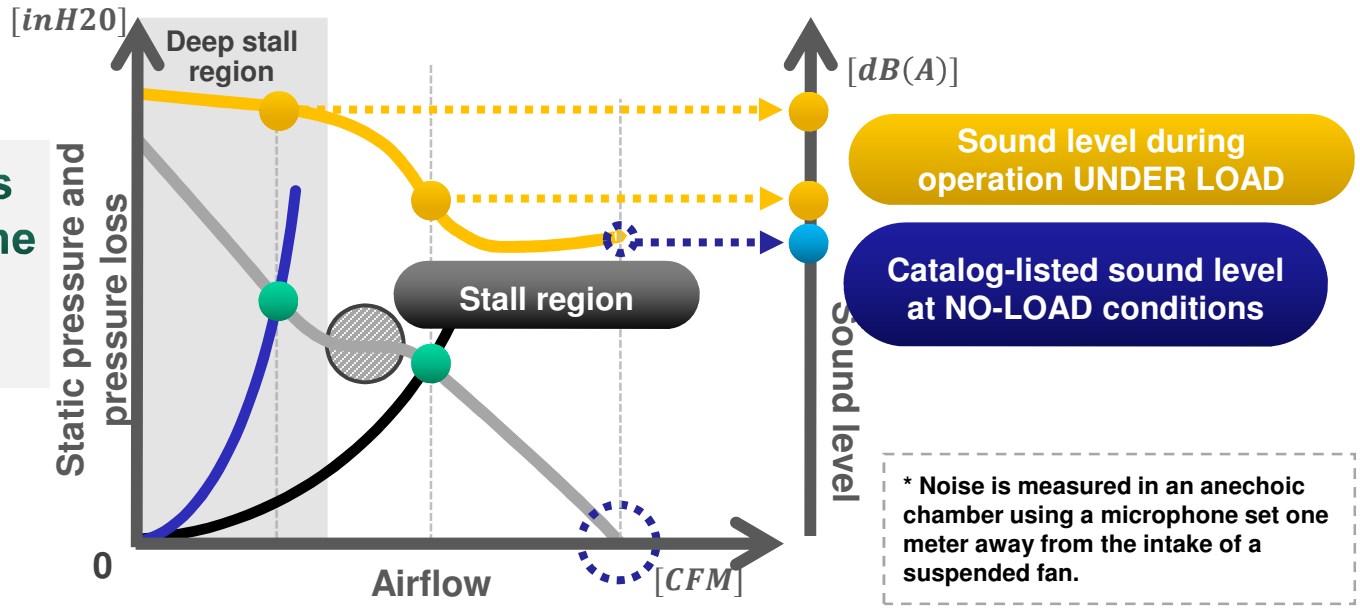
Fan noise varies depending on the operating point (load)



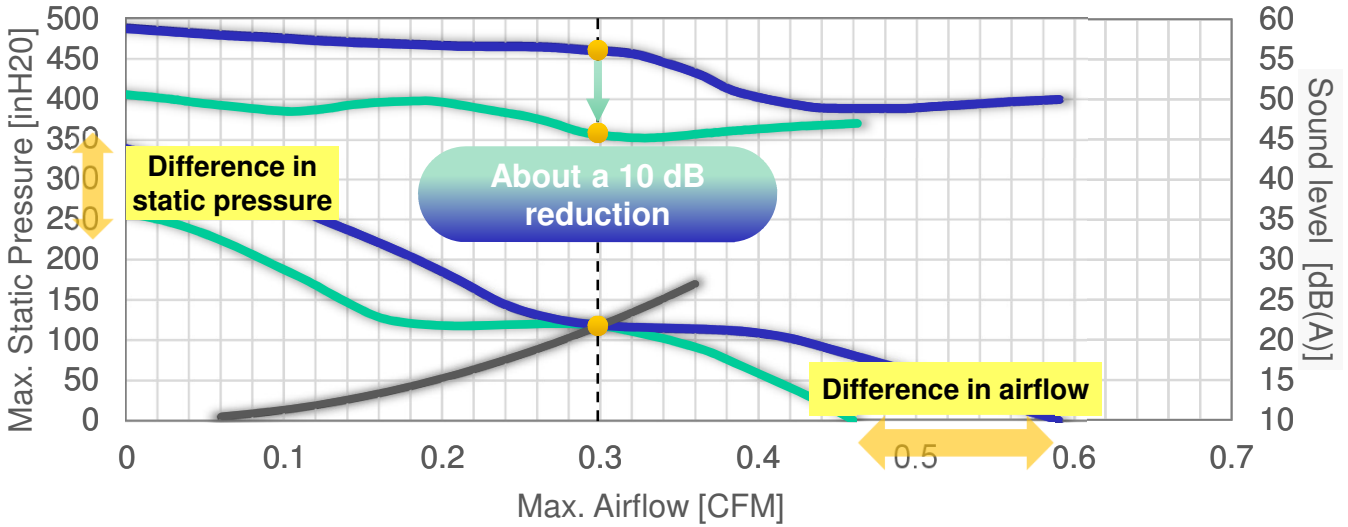
* Noise is measured in an anechoic chamber using a microphone set one meter away from the intake of a suspended fan.

3. Optimizing Noise and Power Consumption

Reducing noise

Example

Size	Model No.	Rated Voltage [V]	Rated Current [A]	Rated Input [W]	Rated Speed [min^{-1}]	Max. Airflow [m^3/min]	Max. Static Pressure [Pa]	SPL [dB(A)]
40 × 28	109P0412K3013	12	0.55	6.6	15,500	0.59	340	50
40 × 28	9GA0412P3M01	12	0.21	2.52	12,500	0.46	258	47



The 2 fan models shown can provide the same performance at the operating point(OP).

However, the 9GA model has a 10 dBA reduction in sound at the OP, even though the max airflow and pressure are less than the 109P model.

Finding a fan optimized for a chassis is very important. Max airflow and pressure are irrelevant.

3. Optimizing Noise and Power Consumption

Reducing power consumption

Catalog excerpt

Model No.	Size	Rated Input $[W]$	Max. Airflow $[m^3/min]$	Max. Static Pressure $[Pa]$	SPL $[dB(A)]$
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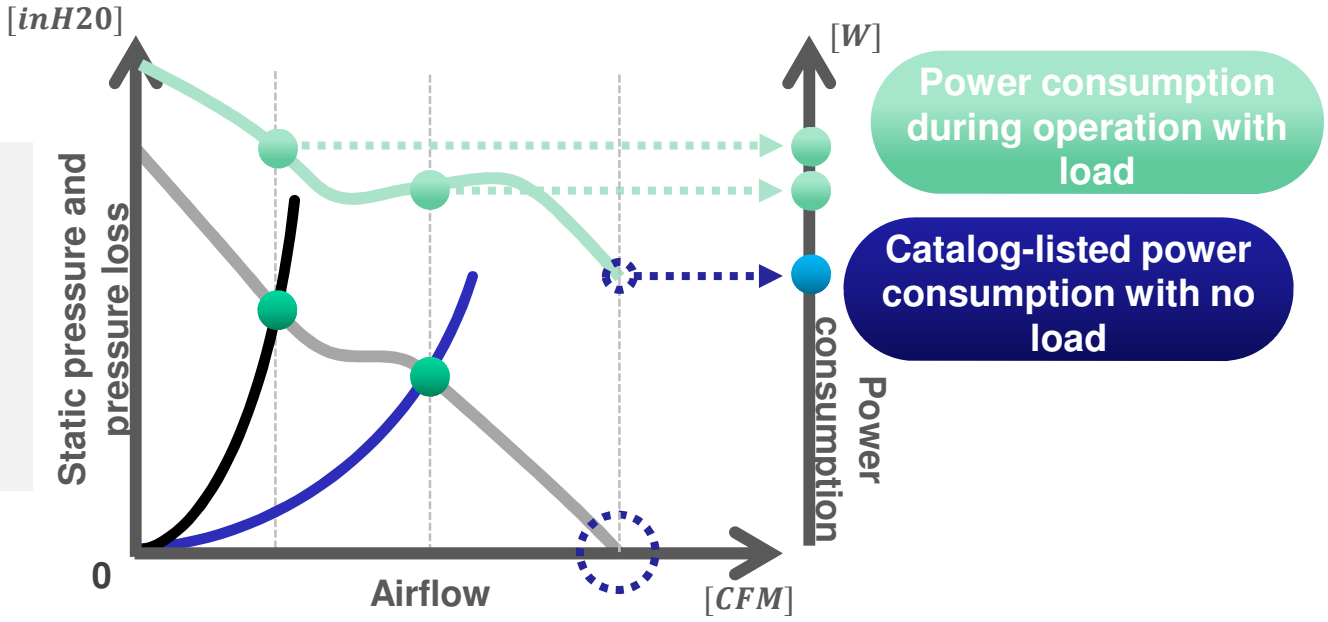
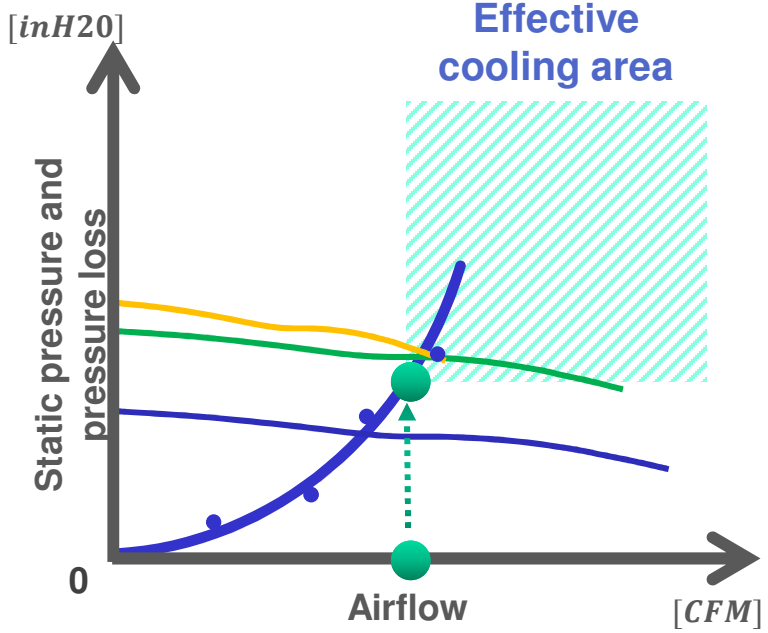
Power consumption varies depending on the operating point (load)



4. Identifying the Best Operating Point

How to select a fan by measuring **system impedance**



STEP1 Measure system impedance

STEP2 Calculate required operating airflow

$$Q' = \frac{V}{k \times \Delta T}$$

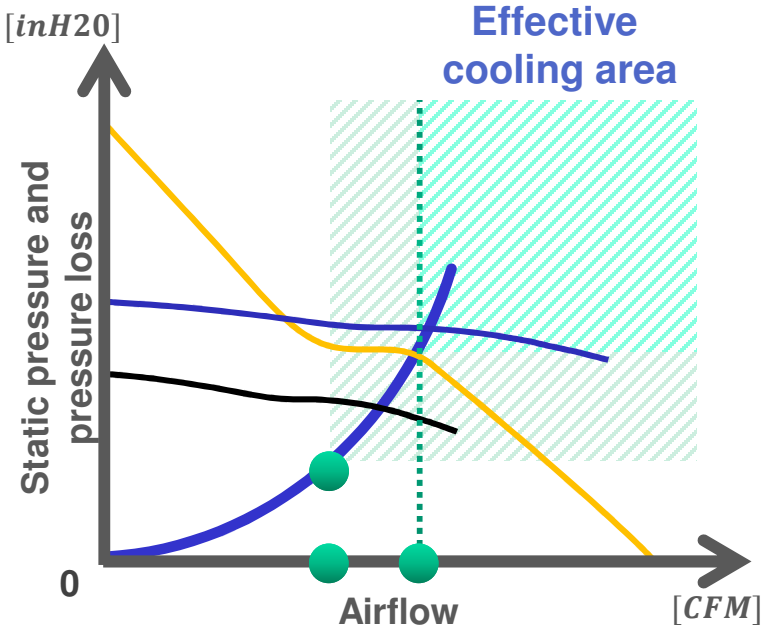
STEP3 Determine effective cooling area

STEP4 Select fan

STEP5 Product evaluation

4. Identifying the Best Operating Point

How to select a fan by measuring **operating airflow**



STEP1 Measure operating airflow of current fan

STEP2 Calculate device system impedance

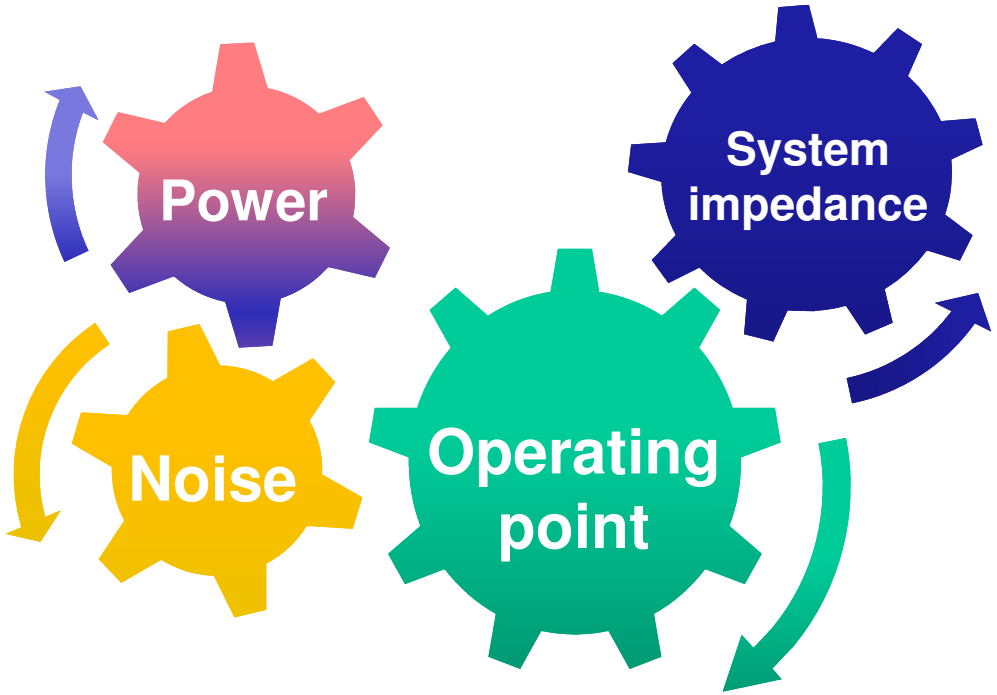
$$P = C \times Q^2$$

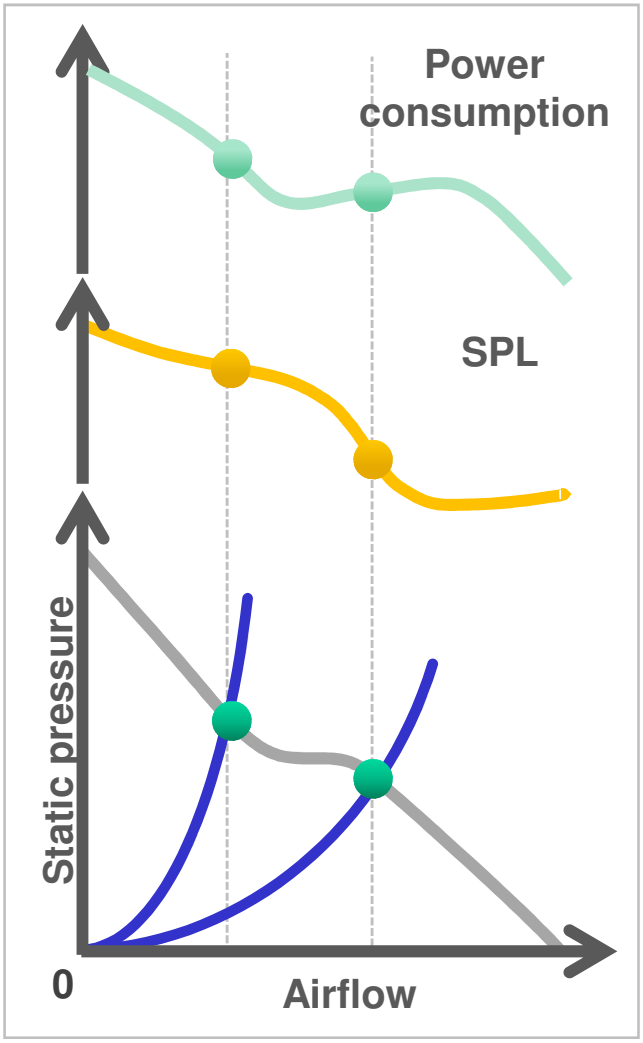
STEP3 Expand effective cooling area

STEP4 Select fan

STEP5 Product evaluation

Ways to select an Optimized fan



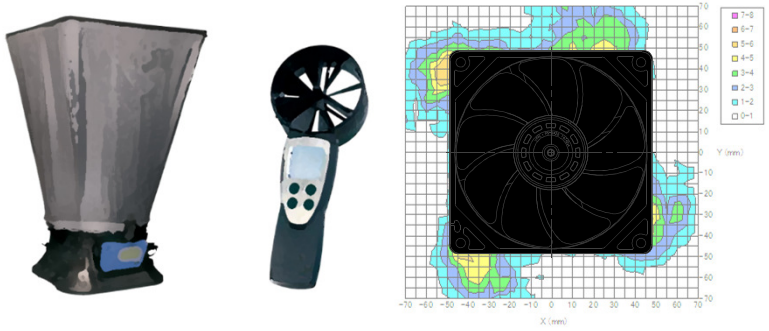


4. Identifying the Best Operating Point

Typical measuring instruments

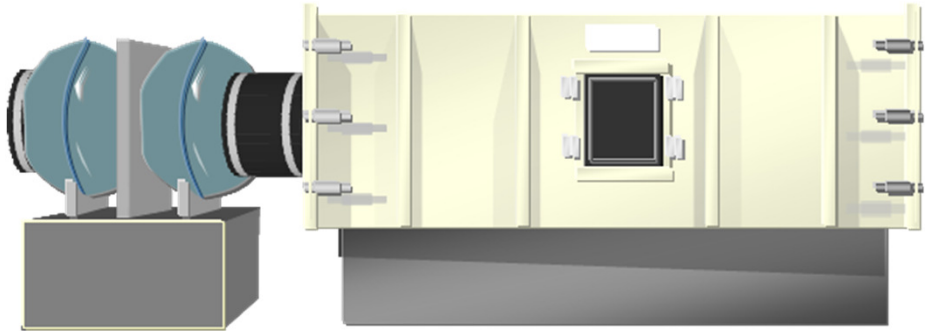
Anemometer

Wind speed



Double chamber measuring device

Airflow | System impedance | P–Q performance



Low cost	Portable	High precision	Easy to measure
Low precision	Difficult to measure	Expensive	Large device

4. Identifying the Best Operating Point

Alternative measuring instrument

Sanyo Denki Portable Airflow Tester

Operating airflow

System impedance

Moderate cost

Portable

Good precision

One button measurement

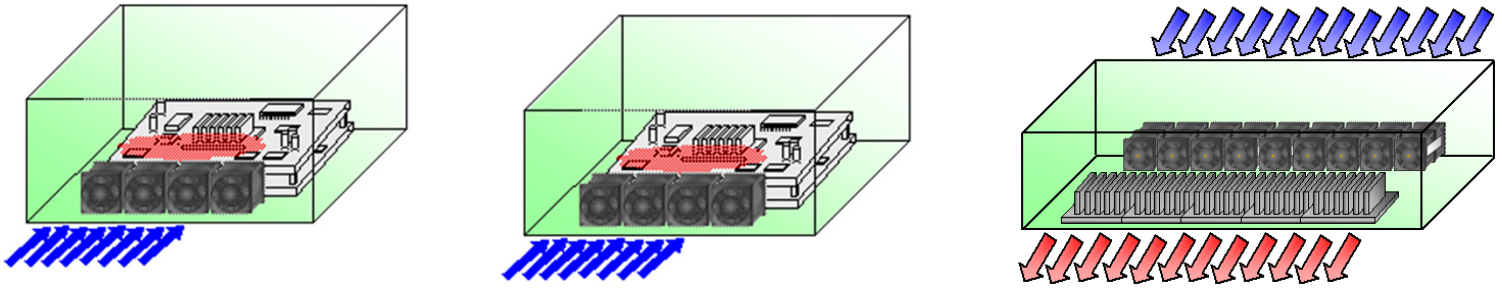
4. Identifying the Best Operating Point

Comparison of main specifications

	Double chamber measuring device	Airflow Tester
Mass	About 600 kg	About 6 kg
Size [mm]	6000 (W) x 1000 (H) x 1000 (D)	600 (W) x 250 (H) x 250 (D)
Airflow [m^3/min]	0.05 to 20	0.2 to 8.0
Static pressure [Pa]	0 to 2,000	0 to 1,000
Measurement method	Double chamber method	
Measurement functions	Operating airflow, system impedance, and P-Q performance	
Measurement accuracy	±2%	±7%

SanAce Airflow Tester

Summary



- Fan specifications listed in catalogs are for conditions with no load.
- When a fan is mounted in a chassis with other components, there will be a pressure load on the fan.
- A system curve is required to know the operating point of the fan in a chassis.
- Selecting a fan based on an optimized operating point for a chassis minimizes noise and power consumption.