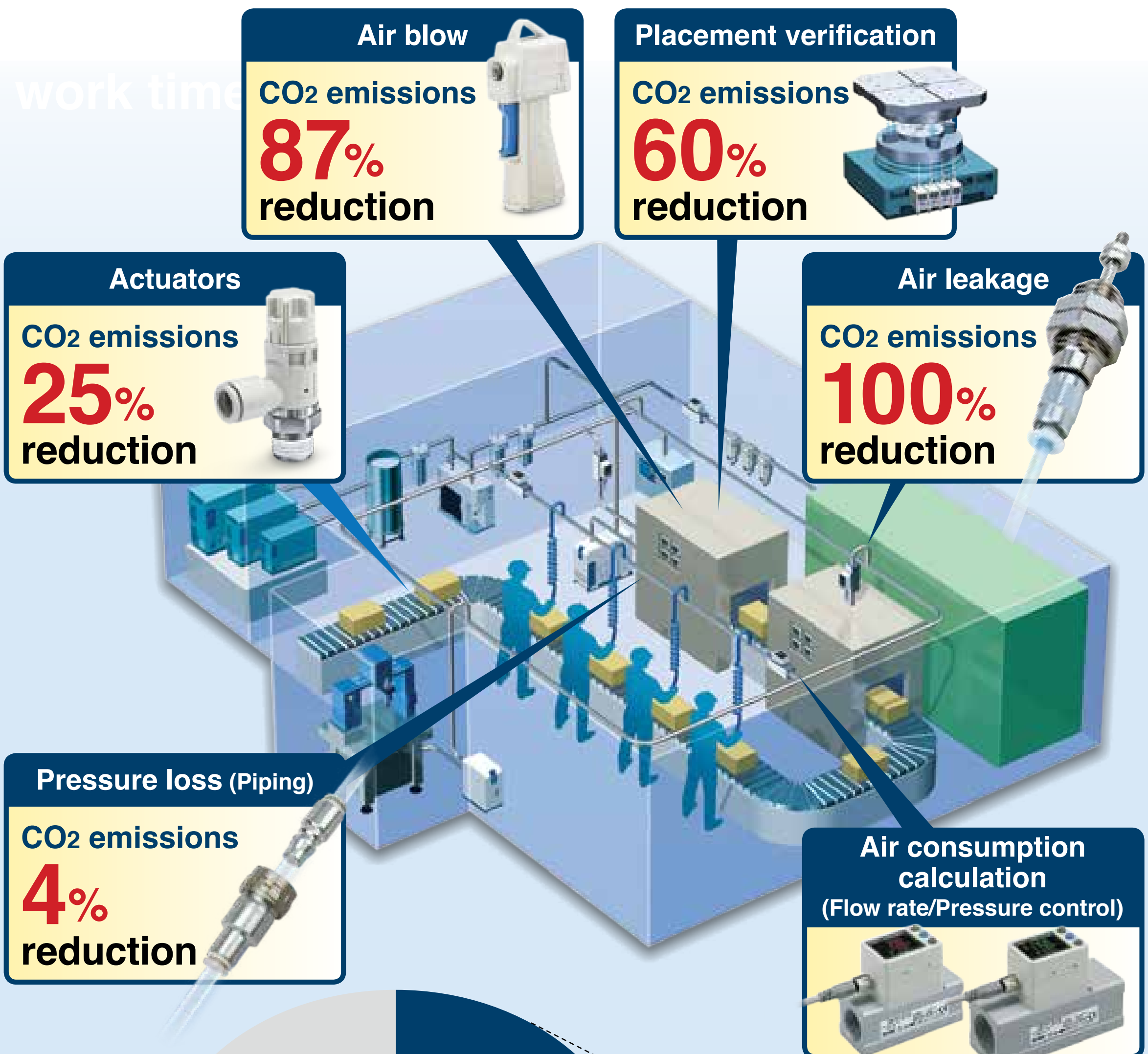
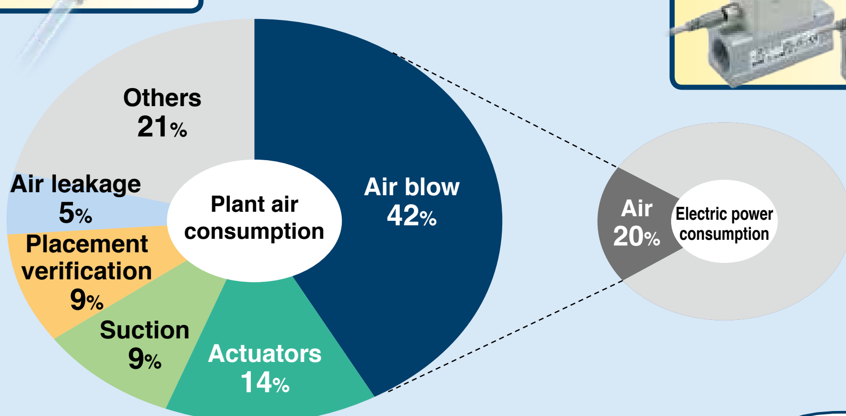
# Proposal for Energy Saving in Factories

Helping you optimize your air pressure




NC444-A
(P-E20-14)

# Environment

## Eco-Management

### SMC Group Code of Conduct – Initiatives on Environmental Issues

We recognize that preservation of global environment is an essential condition for our company's existence and activities as well as a common issue for all humanity. We will work on preserving and improving the environment where people can live safely with rich nature.

❶ We will strive to develop and supply environment-friendly products.
❷ We will consider protection of environment throughout the whole process of business operation.

- We will comply with regulations on banned substances.
- We will ensure proper treatment of wastewater and air exhaustion, and disposal of waste, and will work on reducing waste.
- We will be thorough in our effort to save natural resources and energy.

### Environmental Policy

1. We will identify the environmental impacts of our business activities, products and services and strive to reduce environmental burden and prevent pollution, and to make continual improvement of our environmental management system.
2. We will comply with all environment-related laws, regulations and agreements, and enhance collaboration with our customers, neighbors and local communities.
3. We will minimize the environmental impacts from our design, development and production activities.
   (1) We will promote the development of environment-friendly products.
   (2) We will use energy efficiently to prevent global warming.
   (3) We will promote the reduction and recycling of waste.
4. We will ensure that the action plans are implemented properly to achieve the environmental objectives and goals.
5. We will make this policy known to all as well as release it to the general public.

ISO14001 SMC

This is a logo of SMC's environmental preservation activities. It is a heart-shaped design with a blue earth and a young leaf. The mark appears on our Environmental Policy as well as on documents and bulletins to enhance awareness among our employees.

### CSR Promotion System

SMC has established a CSR Committee chaired by the President and has been taking initiatives in responding to customer requests and inquiries on CSR-related issues.

#### Main Tasks of the CSR Committee

1. To plan, develop and manage policies related to CSR and other matters.
2. To respond to questionnaires on CSR, etc., from users and corresponding to audits (site visits).
3. To conduct audits on the progress of implementation of policies related to CSR, etc.
4. To take necessary measures based on the progress of implementation of policies and audit results related to CSR, etc.

### Environmental Training

SMC offers educational seminars and practical training on environmental issues for its employees, and also provides environmental training for environment-related partner companies. In addition, employees who hold their country's qualifications continuously attend follow-up training to enhance the quality of their knowledge and technical abilities.

**Training conducted in FY2018**

| | |
|---|---|
| Environmental training for employees | 7,219 attendees |
| Emergency response training | 99 attendees |
| Training for front-line workers | 458 attendees |
| Participation in external environment-related training sessions | 19 attendees |
| Environmental training for environment-related partner companies | 138 companies |

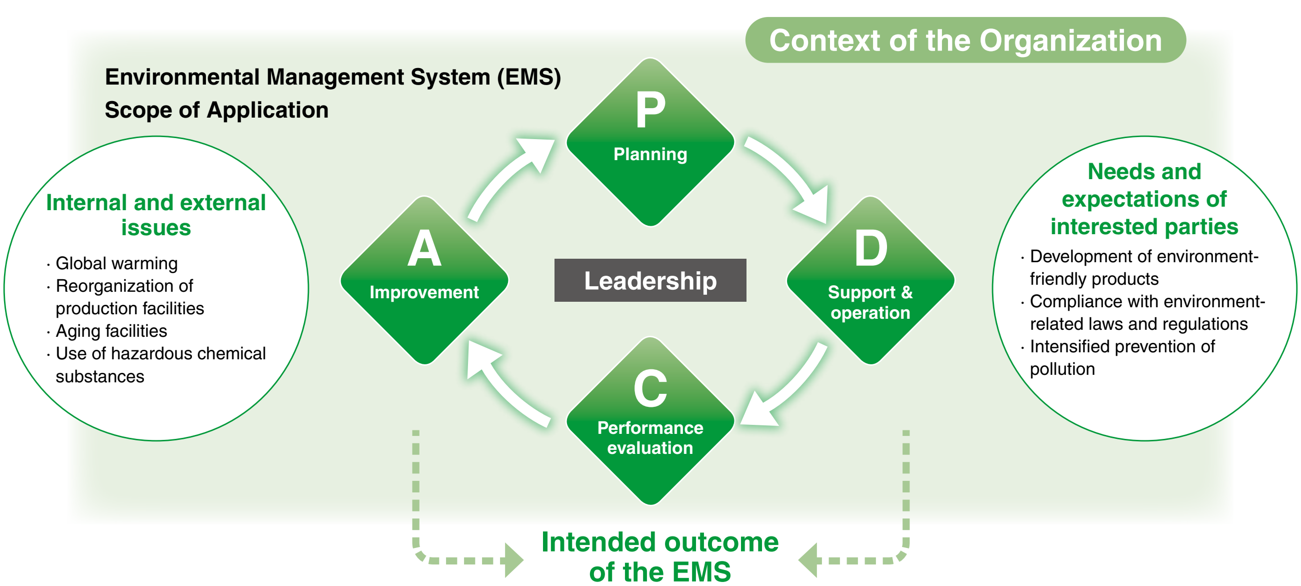
## Environmental Objectives, FY2018 Results and Evaluation

As part of our initiatives under the Environmental Management System (EMS) which adheres to ISO 14001, SMC defines "Environmental Objectives" to be achieved over a period of three years and "Environmental Targets" for each fiscal year, and manages and evaluates the progress.
In FY2018, out of the "Environmental Targets" described below, we achieved all except for "Saving of resources". "Saving of resources" was not accomplished due to the effect of increased waste from packaging material (wooden crates and wooden pallets) accompanying overseas manufactured products.

1. SMC conducted product assessments to be utilized for the design and development of environmentally-friendly products.
2. As an initiative to prevent global warming, SMC achieved a 18.4% reduction of $CO_2$ emissions per unit of production compared to the Sixth Term (FY2014-2016) average. As an initiative to save resources, SMC achieved a 1.8% reduction of waste discharged per unit of production compared to the Sixth Term (FY2014-2016) average.
3. All regional groups consisting of our major production facilities participated in climate change actions organized by local governments and industry groups and community beautification activities, as well as conducted awareness building programs for employees.

| | Environmental Objectives<br>Goals to achieve in 3-year period of FY2017-2019 | Environmental Targets for FY2018 | Results | Evaluation |
|---|---|---|---|---|
| **Product assessments (Environmental compatibility)** | Design and development of environmentally-friendly products<br>Conducted assessments using score evaluation of current status<br>Total of 75 models or more in three years: 900 points or higher | Design and development of environmentally-friendly products<br>Conducted assessments using score evaluation of current status 25 models or more: 300 points or higher | 37 models: 345 points | Achieved |
| **Business activities (Environmental conservation)** | Promote energy-saving, resource-saving and reduction of environmental burden through beneficial environmental activities in our business activities | | | |
| | Prevention of global warming<br>Reduction of $CO_2$ emission<br>Sixth Term (FY2014-2016): Average of 10% or more reduction per unit of production | Reduction of $CO_2$ emission<br>Reduce 8% or more compared to the Sixth Term (FY2014-2016) average per unit of production | 18.4% reduction | Achieved |
| | Saving of resources<br>Reduction of waste discharge<br>Sixth Term (FY2014-2016): Average of 10% or more reduction per unit of production | Reduction of waste discharge<br>Reduce 8% or more compared to the Sixth Term (FY2014-2016) average per unit of production | 1.8% reduction | Not achieved |
| **Communication (Coexistence with society)** | Social contribution activities<br>Community beautification activities | Social contribution activities<br>Community beautification activities | All regional groups conducted as planned | Achieved |
| | Promotion of climate change actions | Promotion of climate change actions<br>Participation in initiatives organized by local governments and industry groups<br>Conduction of education and awareness building programs | All regional groups conducted as planned | Achieved |

## Framework of ISO 14001:2015



# Proposal for Energy-saving, Compact, and

## Air supply

Compressor

## Air preparation equipment

• Aftercooler
• Tank

Main line filter

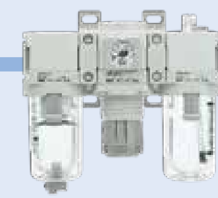
Air dryer

## Fittings and Tubing

S Coupler
Tubing

## Air combination Pressure control equipment

• Filter
• Regulator
• Lubricator



First, figure out how much air is currently being used.

**1**

Plan piping in a way that saves energy.

**3** **4** **5**

Don't let any pressure go to waste! A few minor revisions → energy savings!

**4**

Are you replacing your elements?

**4**

### 1 Air consumption calculation

p. 7 ▸ 10

• Flow rate measurement
• Air blow measurement
• Pressure measurement

### 2 Air blow efficiency

p. 11 ▸ 17

Nozzles for blowing

Impact blow gun

Impact blow valve

### 3 Reduce air leakage

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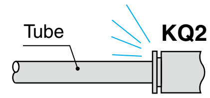
Air leakage from the One-touch fitting




Installation of a solenoid master valve

VXD

### 4 Reduce pressure loss

p. 21 ▸ 26

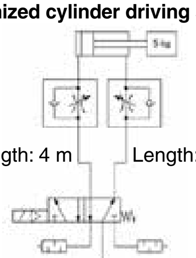
Coupler

Air filter clogging

### 7 Energy-saving circuit

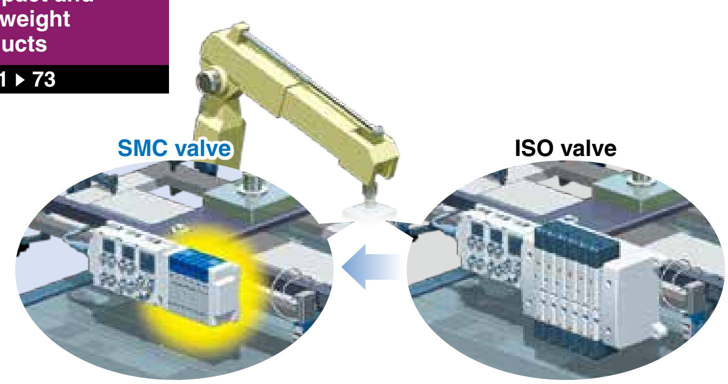
p. 46 ▸ 50

Optimized cylinder driving system




### 8 Compact and lightweight products

p. 51 ▸ 73



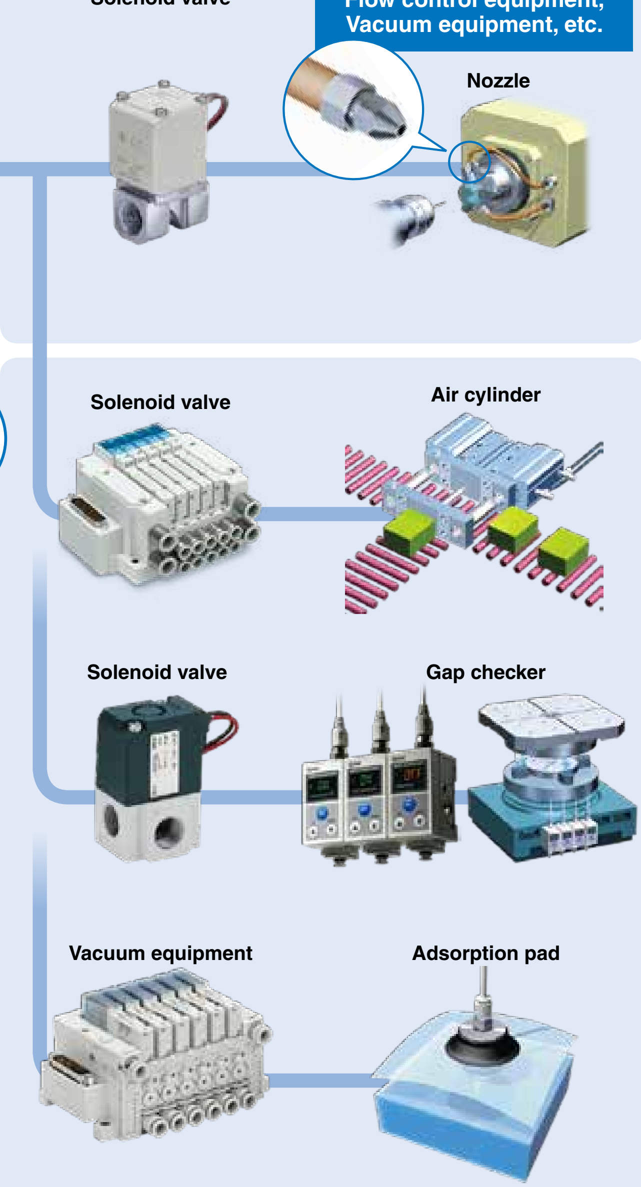
# Lightweight Air Systems

**Pressure sensor devices**
**Flow sensor devices**

- Flow switch
- Pressure switch

**Directional control valve**

**Air consuming devices, Blow guns, Actuators, Flow control equipment, Vacuum equipment, etc.**




Are your operating conditions ideal? → **5**

Air blow adjustments can lead to large energy savings! → **2**

Search for air-saving themes for each device. → **6**

## 5 Air pressure source efficiency

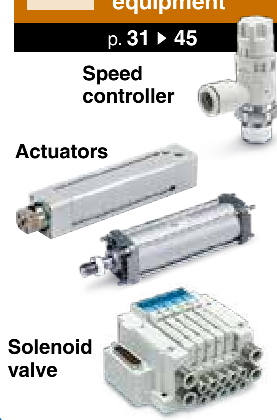
p. 27 ▸ 30

- Reduce specific power
- Improve operation efficiency

Compressor

## 6 Air/Power saving equipment

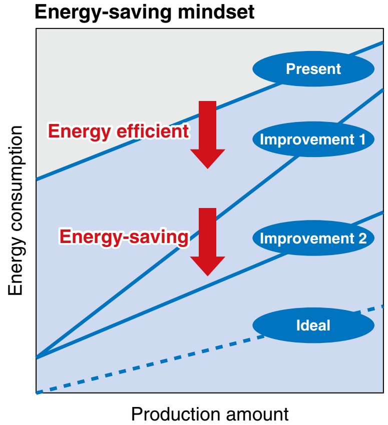
p. 31 ▸ 45



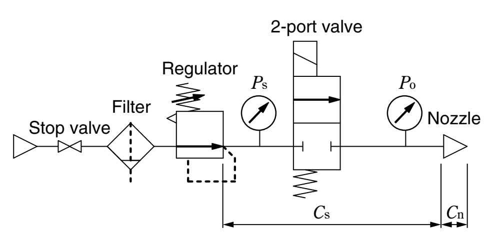

## 9 Technical data

p. 74 ▸ 81

**Energy-saving mindset**




**Changes in upstream conductance pressure loss**




Recommended air blow system

# We will help you save energy.

## Successful cases of companies that implemented measures for energy saving

| Company A performance | |
|---|---|
| Electricity | 3000 kWh ➡ 1400 kWh |
| $CO_2$ | 0.9 t reduction/year |
| Cost | $743,348 reduction/year |

| Company B performance | |
|---|---|
| Electricity | 10000 kWh ➡ 7000 kWh |
| $CO_2$ | 1.7 t reduction/year |
| Cost | $1,403,168 reduction/year |

- **We will help you to improve and standardize your equipment and adopt new equipment.**
- **We also proactively promote activities through official organizations, such as holding seminars at the Energy Conservation Center.**

**For energy saving in pneumatic systems, implement a PDCA cycle such as the one below. When following a PDCA cycle, the measuring of the usage amount before and after implementation is very important.**

| | | | |
|---|---|---|---|
| **P** Plan | Reduction goals | • Decide on a reduction goal. | |
| | ↓ Air consumption calculation | • Measure the usage amount of the factory as a whole and of the equipment as a whole.<br>• Doing so will help you figure out the usage amount per application, per type of equipment, and per piece of equipment. | References for flow rate and pressure control p. 74 |
| | ↓ Energy-saving theme selection | • In order to improve energy savings, select a theme according to the difficulty level and effectiveness of the measures, keeping horizontal development in mind.<br>• Look for past examples and examples from books for reference. | References for how to approach energy saving p. 75 |
| **D** Do | ↓ Implementation of energy-saving measures | • Implement the measures. | |
| **C** Check | ↓ Measuring the effectiveness of the measures | • Measure the usage amount after the measures have been implemented to measure their effectiveness. | References for flow rate and pressure control p. 74 |
| **A** Action | ↓ Horizontal expansion/ Additional measures Monitoring of usage amounts | • Implement horizontal development measures.<br>• If reduction goals aren't met, additional measures or a plan adjustment may be considered.<br>• Monitor the usage amount, etc., to detect improvements obtained from the implemented measures. | |

CONTENTS

# 1 Air consumption calculation



**UNIT CONVERSIONS**

| | unit | conversion | result |
|---|---|---|---|
| length | m | x 3.28 | ft |
| | mm | x 0.04 | in |
| mass | g | x 0.04 | oz |
| volume | $cm^3$ | ÷ 16.387 | $in^3$ |
| | L | x 61.024 | $in^3$ |
| speed | mm/s | ÷ 25.4 | in/s |
| pressure | MPa | x 145 | psi |
| | kPa | ÷ 6.895 | psi |
| temperature | °C | x1.8 then add 32 | °F |
| torque | N·m | x 0.738 | ft-lb |
| force | N | ÷ 4.448 | lbf |
| flow | L/min | ÷ 28.317 | cfm |
| | JPY | x 0.0094 | dollar |

# 1 Air consumption calculation — Figuring out the cost of compressed air

**As compressed air cannot be seen by the naked eye and can be released to the atmosphere without causing any harm, it's easy to remain unaware of how much it's costing. By figuring out the cost of compressed air (per unit), it is possible to calculate the annual cost of the compressed air being used in your pneumatic system. The following equation is the standard calculation method for finding the cost of compressed air.**

Cost of compressed air [JPY/m³ (ANR)]

$$= \frac{\text{Electric power consumption [JPY/year]} + \text{Operating costs [JPY/year]} + \text{Maintenance costs [JPY/year]} + \text{Cost of equipment [JPY/year]}}{\text{Amount of air used for compressed air [m}^3\text{ (ANR)]}}$$

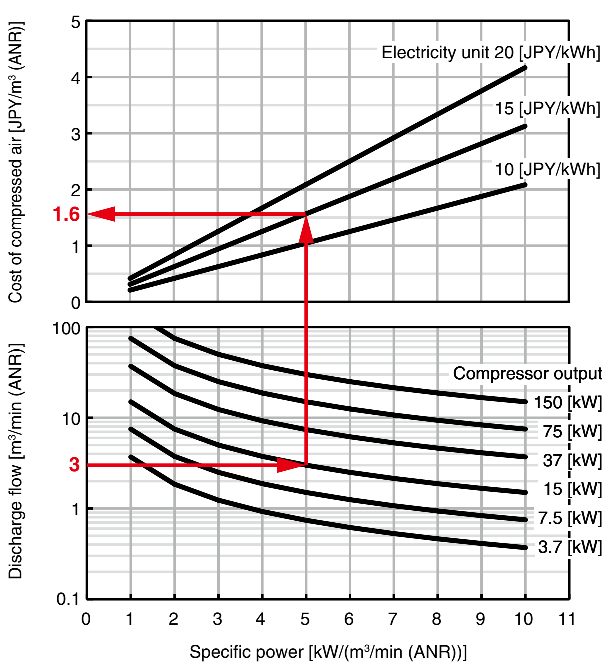
The cost of compressed air can be calculated using the actual values of combined total costs and the amount of compressed air used.

## Calculation method

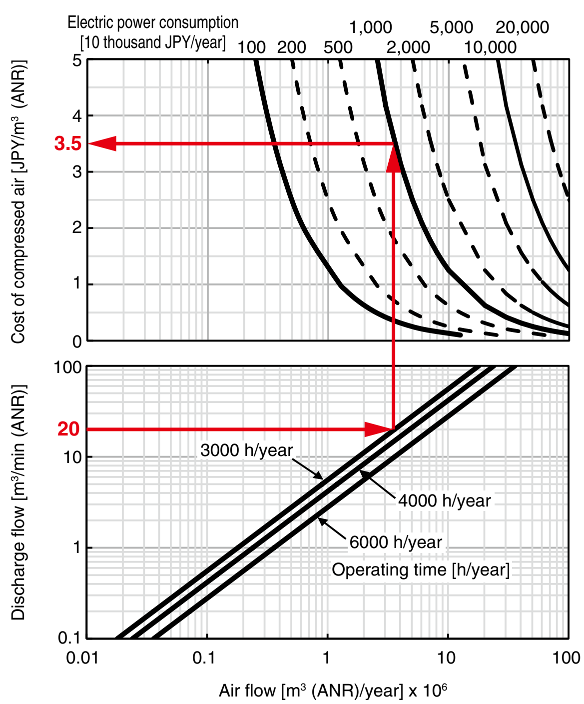
The following equation is a simple calculation method for figuring out the cost of compressed air.

Calculation method ①···Calculating from the specific power
- The specific power can be found using the compressor rated output and discharge amount.
- The combined total of operating costs, maintenance costs, and the cost of equipment can be estimated to make up 25% of the cost.

Calculation method ②···When the amount of air and costs other than the cost of electricity are unknown
- The amount of air being used can be estimated as follows: operating hours x rated air discharge amount
- The combined total of operating costs, maintenance costs, and the cost of equipment can be estimated to be 25% of the cost of electricity.




Graph 1 Calculation method 1




Graph 2 Calculation method 2

Calculation example

When the compressor has a 15 kW output, a 3 m³/min (ANR) discharge flow, and the cost of electricity is 15 JPY/kWh

① Go up in a vertical line from the point of intersection of 3 m³/min (ANR) discharge flow and 15 kW compressor output.

② If you look to the left of the point of intersection with 15 JPY/kWh as the cost of electricity, you'll see that the cost of compressed air is 1.6 JPY/m³ (ANR).

Calculation example

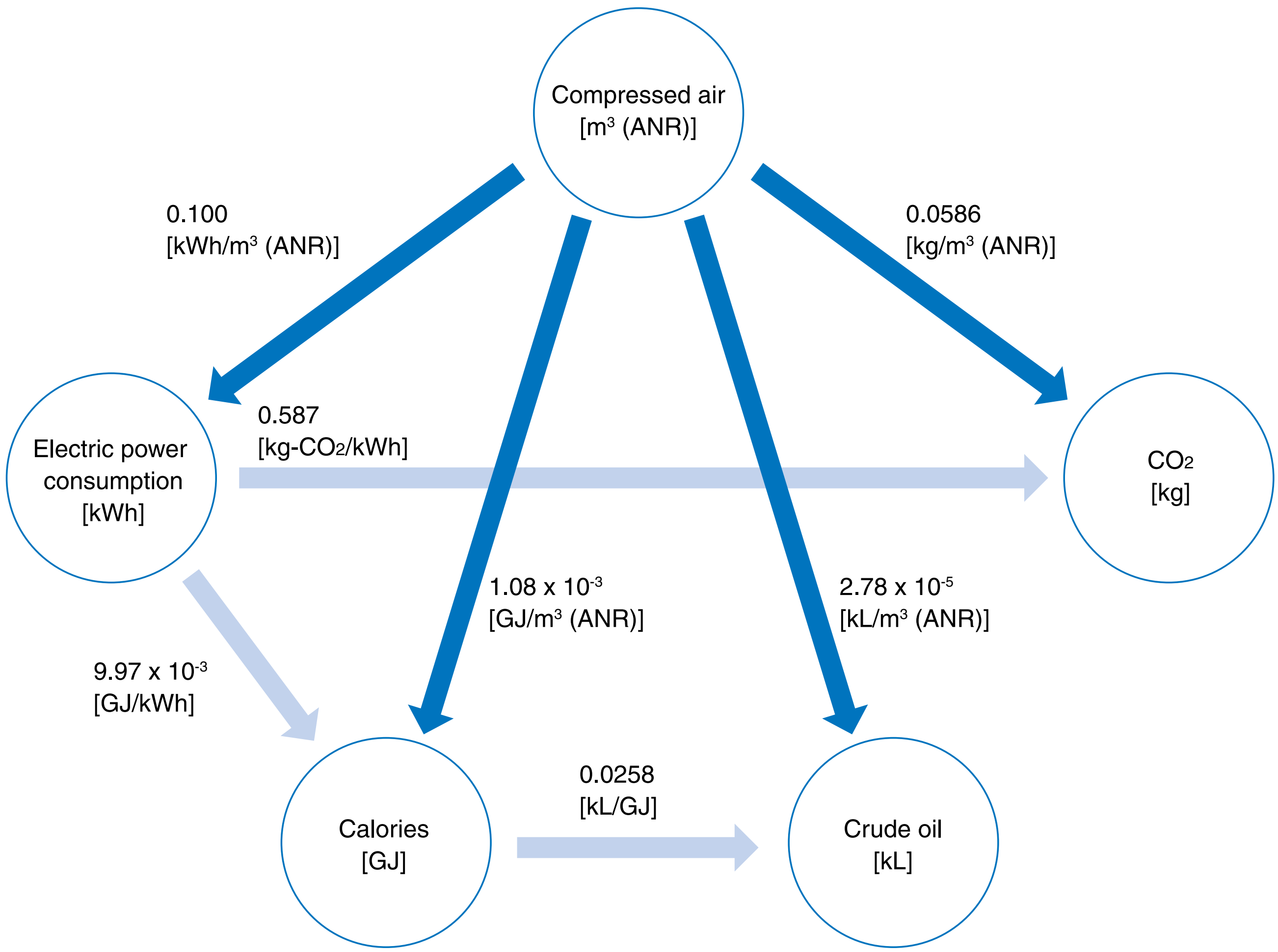
When the compressor is operated for 3,000 hours/year, has a 20 m³/min (ANR) discharge flow, and electricity costs 10 million JPY/year to operate it

① Go up in a vertical line from the point of intersection of 20 m³/min (ANR) discharge flow and 3,000 hours of operation/year.

② If you look to the left of the point of intersection with 10 million JPY/year as the cost of electricity, you'll see that the cost of compressed air is 3.5 JPY/m³ (ANR).

# Calculation of compressed air energy

**To calculate the amount of compressed air per unit, the amount of electricity consumption, $CO_2$, calories, and crude oil are used.**

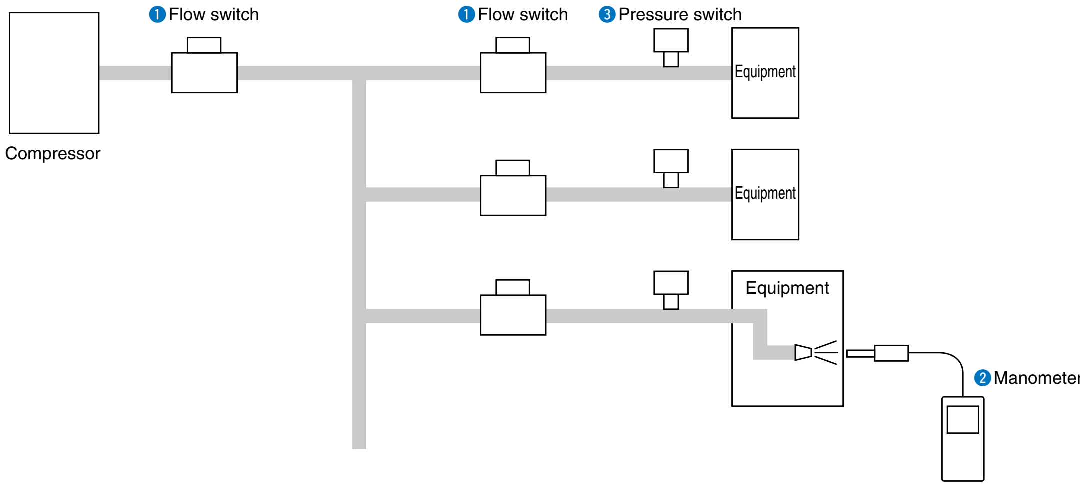



## Conversion factor

- Calculated with the specific power = 6 [kW/(m³/min (ANR))]
- Amount of electricity consumption ➡ $CO_2$ conversion factor
  Quote: The Ministry of the Environment's website
  Emission factors of electricity business operators (For the calculation of greenhouse gas emission amounts of specified businesses) — 2015 fiscal year results — Officially announced on December 27, 2016: (Substitute values)
- Amount of electricity consumption ➡ Calorie conversion factor
  Quote: The Agency for Natural Resources and Energy's website
  Based on the annual reports of energy consumption in accordance with Article 15 and Article 19 (2) of the Act on Rationalizing Energy Use — February 7, 2017 revision: Use of daytime power purchase
- Calories ➡ Crude oil conversion factor
  Quote: Same as above

# Pressure and flow rate control

**In order to figure out how much air is currently being used in your pneumatic system and to measure the effectiveness of the implemented measures, it is necessary to measure the flow rate and pressure. In addition, measuring the flow rate and pressure is also necessary in order to monitor the effectiveness and further improve upon the measures.**




## Measure the flow rate of the main line and of each device.

Measure the flow rate of each device and of the factory as a whole in order to figure out how much air is currently being used as well as to measure the effectiveness of the implemented measures.

1 Flow switch

## Measure the air blow impact pressure.

In order to improve air blow, measure the impact pressure.

2 Manometer

## Measure the pressure at each device.

Monitor pressure drops between the compressor and the devices.

3 Pressure switch

# 2 Air blow efficiency



**UNIT CONVERSIONS**

| | unit | conversion | result |
|---|---|---|---|
| length | m | x 3.28 | ft |
| | mm | x 0.04 | in |
| mass | g | x 0.04 | oz |
| volume | $cm^3$ | ÷ 16.387 | $in^3$ |
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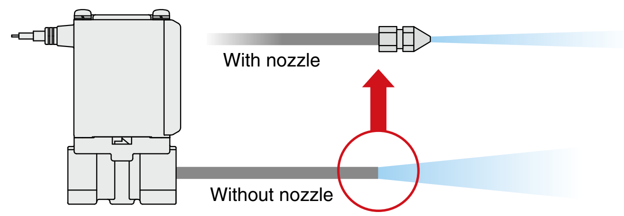
| force | N | ÷ 4.448 | lbf |
| flow | L/min | ÷ 28.317 | cfm |
| | JPY | x 0.0094 | dollar |

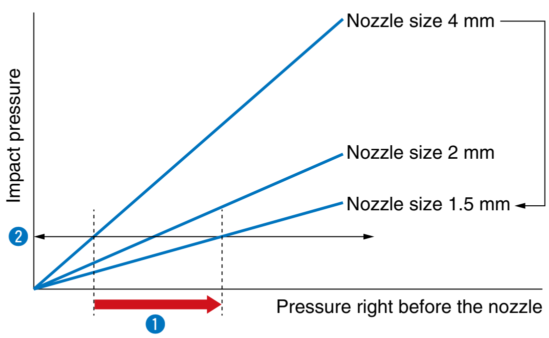
# Nozzles for Blowing *KN Series* 1

**$CO_2$ emissions (Air consumption)**
**61% reduction**

## Install a suitable nozzle where soft copper piping, etc., is cut and used as is to conduct blow.




**Comparison of Blow Effectiveness (Impact Pressure)** Note: Fixed distance



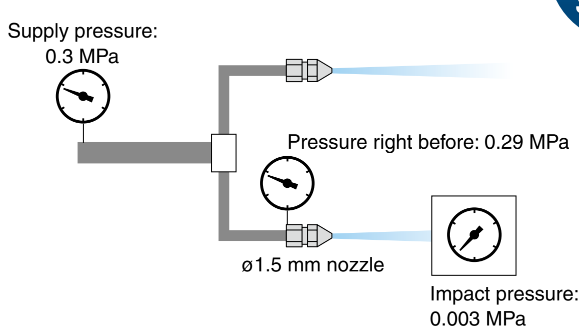

By installing a suitable nozzle, the pressure right before the nozzle will rise immediately (1), resulting in improved blow efficiency. When the same operation is performed (2), air consumption can be reduced.

Nozzle with self-align fitting/ **KN**

Nozzle with male thread/ **KN**

**Effects of Energy Saving**

## Energy-saving Model




Collective piping: TU0805, 2 m
Intermediate and end piping: TU0604, 0.5 m each
Distance: 100 mm

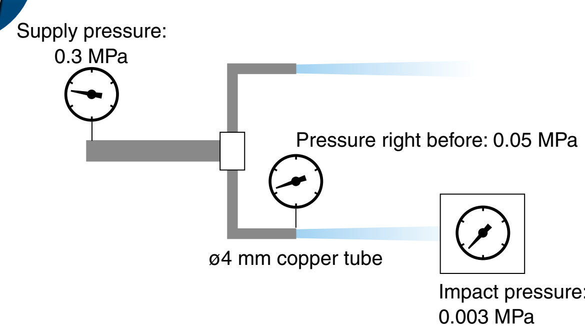
Air consumption per nozzle:
**74 L/min (ANR)**

Blow time: 2 sec.
Annual operating cycles: 900000

**4464 m³/year (ANR)**
$CO_2$ emissions: **261** kg/year
**414** kg reduction in annual $CO_2$ emissions
(**$63**/year)
**($99/year reduction)**

**61% reduction**

## Existing Model

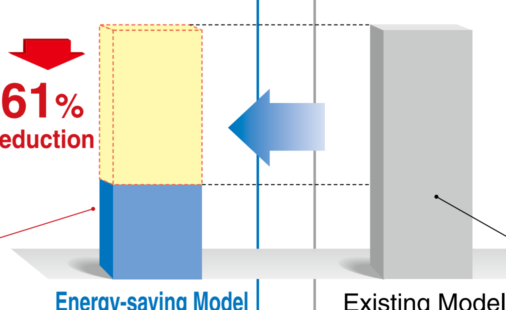



Collective piping: TU0805, 2 m
Intermediate and end piping: TU0604, 0.5 m each
Distance: 100 mm

Air consumption per copper tube:
**192 L/min (ANR)**

Blow time: 2 sec.
Annual operating cycles: 900000

**11520 m³/year (ANR)**
$CO_2$ emissions: **675** kg/year
**$162**/year)



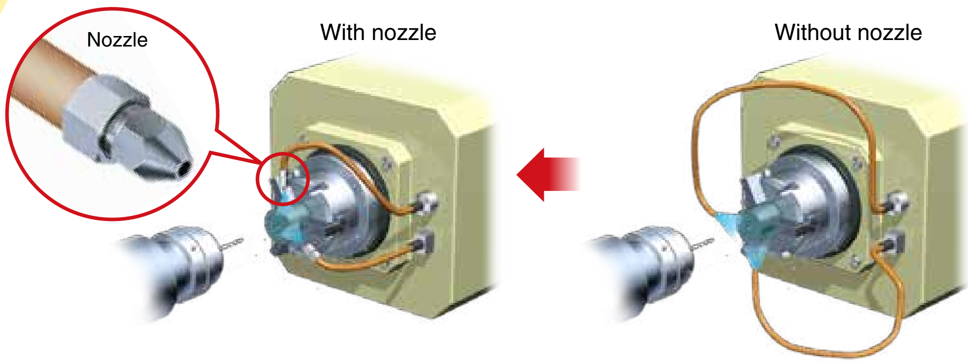

Corresponding value: Air unit $0.014/m³ (ANR), Air – $CO_2$ conversion factor 0.0586 kg/m³ (ANR)

# Nozzles for Blowing *KN Series* 2

**$CO_2$ emissions**
**(Air consumption)**
**40% reduction**

## Overall improvements can be seen by installing nozzles and revising piping and blow positioning.

- Shorter copper pipes/Improved pipe branching
- Examination of blow position/Examination of number of blow operations
- Examination of hours of blow operation




**Effects of Energy Saving**

### Energy-saving Model

Reduced length and number of bends in copper pipes
Attachment of a nozzle (ø2) at the end of copper pipes

Flow rate per nozzle:
**171 L/min (ANR)**

Blow time: 2 sec.
Annual operating cycles: 900000

**5130 $m^3$/year** (ANR)
$CO_2$ emissions: **301** kg/year
**200** kg reduction in annual $CO_2$ emissions

(**$72**/year)
**($48/year reduction)**

### Existing Model

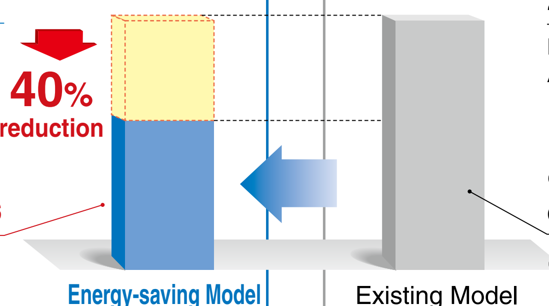
Copper pipes with a lot of bends
Air blow directly from copper pipes

Flow rate per copper tube:
**285 L/min (ANR)**

Blow time: 2 sec.
Annual operating cycles: 900000

**8550 $m^3$/year** (ANR)
$CO_2$ emissions: **501** kg/year

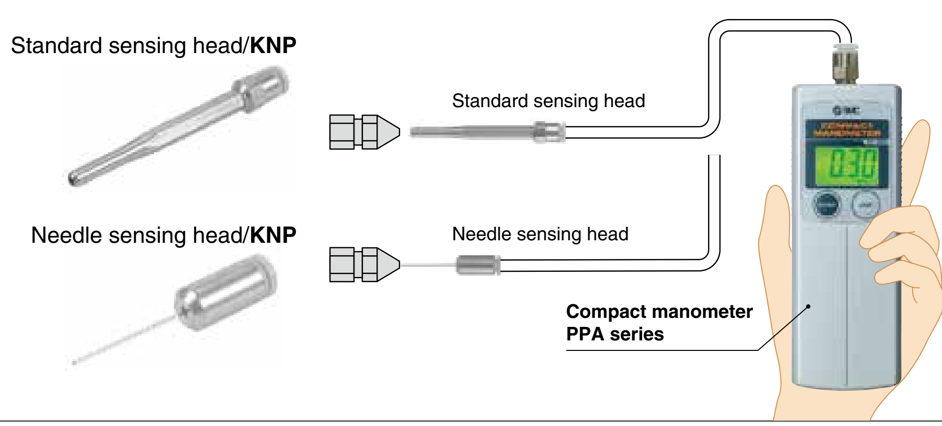
(**$120**/year)




Corresponding value: Air unit $0.014/$m^3$ (ANR), Air – $CO_2$ conversion factor 0.0586 kg/$m^3$ (ANR) ∗ Refer to the "Energy Saving Program" on the SMC website for further details.

## Related Products

Use to measure workpiece collision pressure.



# Blow Gun *VMG Series*

**CO2 emissions (Power consumption)**
**20% reduction**

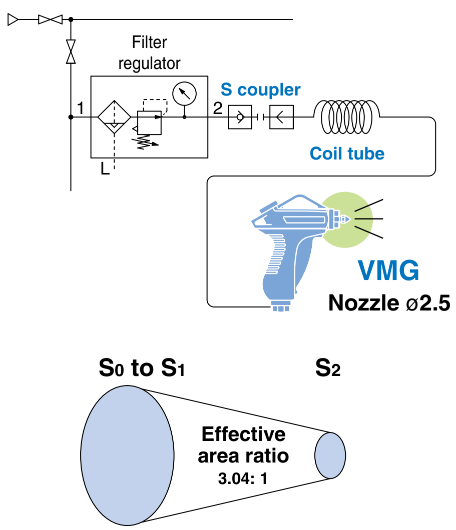
## Power consumption can be reduced by 20% with the SMC blow gun + S coupler + coil tube combination.

∗ 10% reduction with only the blow gun (VMG)

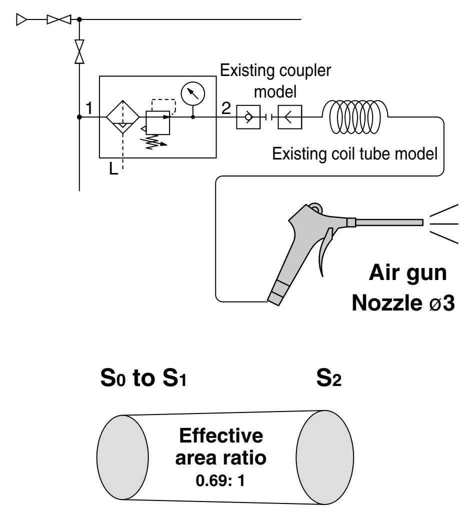

## Example of Improvement

Review the blow work and change to the SMC blow gun, S coupler, and coil tube combination to create a larger effective area.

**After improvement**




**Before improvement**

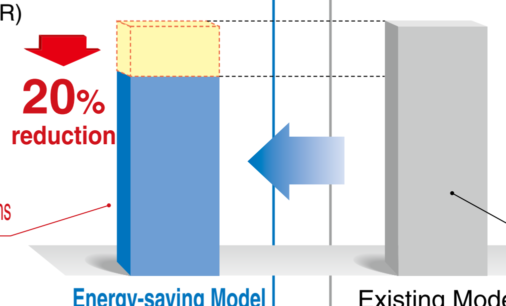



**Effects of Energy Saving**

### Energy-saving Model

Impact pressure: 0.011 MPa (Distance: 100 mm)
Blow time: 10 s (Frequency: 12 times/h)
Working hours: 10 h/day (250 days/year)
Total working hours: 8300 h
Compressor pressure: **0.5 MPa**
Air consumption: **257 L/min** (ANR)

Power consumption by compressor:
**1.25 kW**
$CO_2$ emissions: **6090** kg/year
**1511** kg reduction in annual $CO_2$ emissions
(**$1456**/year)
**($361/year reduction)**




### Existing Model

Impact pressure: 0.011 MPa
(Distance: 100 mm)
Blow time: 10 s
(Frequency: 12 times/h)
Working hours: 10 h/day
(250 days/year)
Total working hours: 8300 h
Compressor pressure: 0.6 MPa
Air consumption: 287 L/min (ANR)

Power consumption by compressor:
**1.56 kW**
$CO_2$ emissions: **7601** kg/year
(**$1817**/year)

Corresponding value: Electricity unit $0.014/kWh, Power consumption – $CO_2$ conversion factor 0.587 kg - $CO_2$/kWh

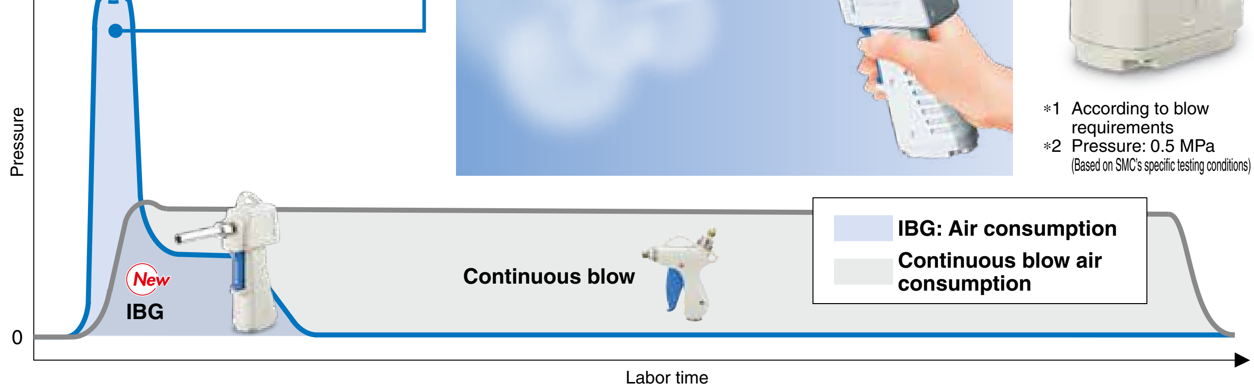
# Impact Blow Gun *IBG* Series

**High peak pressure**
**3 times or more**[*1]
(Compared with the existing model)

**$CO_2$ emissions (Air consumption)**
**87% reduction**[*2]

## Increased impact force due to higher peak pressure Drastic reduction in air consumption and labor time


*1 According to blow requirements
*2 Pressure: 0.5 MPa
(Based on SMC's specific testing conditions)




**Effects of Energy Saving**

## Energy-saving Model

Application examples:
Cutting chip removal
Pressure: 0.5 MPa[*1]
Nozzle size: ø10
Removal time (1 operation):
0.1 s
Air consumption:
0.8 L (ANR)

*1 The removal of cutting chips adhered to the clamping unit

When operating for 2500 hours/year,
120 removal operations/hour

*240 m³/year (ANR)

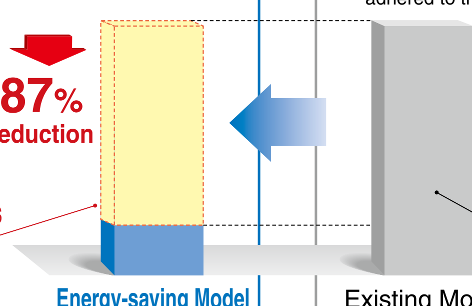
$CO_2$ emissions: 14 kg/year

*96 kg reduction in annual $CO_2$ emissions

**($3/year)**

**($23/year reduction)**

**87% reduction**




## Existing Model

Application examples:
Cutting chip removal
Pressure: 0.5 MPa[*1]
Nozzle size: ø2
Removal time (1 operation):
3.1 s
Air consumption:
6.3 L (ANR)

*1 The removal of cutting chips adhered to the clamping unit

When operating for 2500 hours/year,
120 removal operations/hour

**1890 m³/year (ANR)**

$CO_2$ emissions: **110** kg/year

**($27/year)**

Corresponding value: Air unit $0.014/m³ (ANR), Air – $CO_2$ conversion factor 0.0586 kg/m³ (ANR)

# Impact Blow Valve *IBV10-X5*

High peak pressure

**3 times or more***1

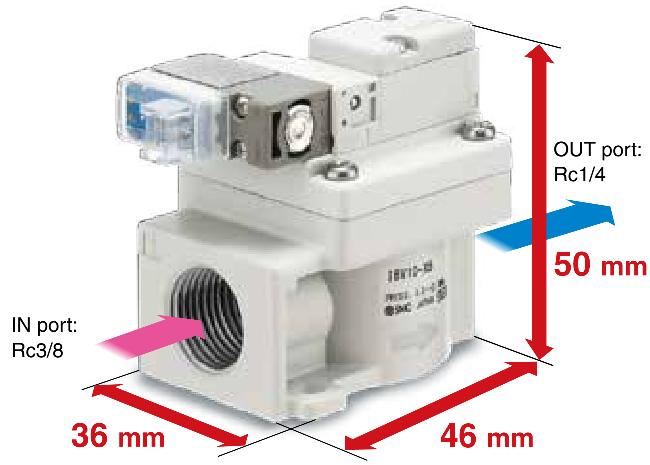
(Compared with the existing model)

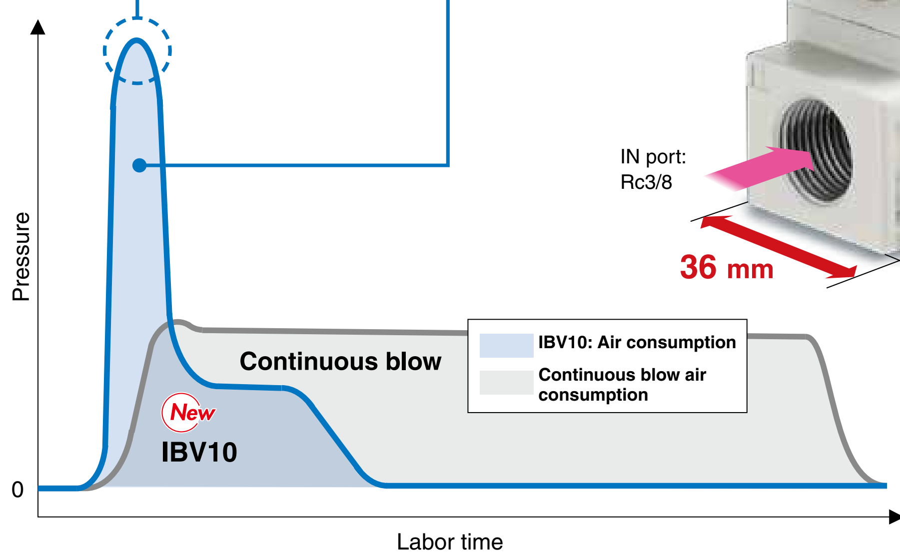
$CO_2$ emissions (Air consumption)

**93% reduction***2

## Increased impact force due to higher peak pressure Drastic reduction in air consumption and labor time

**Solenoid Type/IBV10-X5**



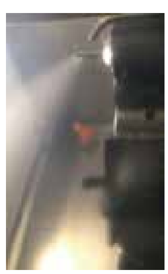

*1 According to blow requirements When the piping volume is 100 cc (Piping I.D. ø13, 800 mm)
*2 Pressure: 0.5 MPa (Based on SMC's specific testing conditions)

**Effects of Energy Saving**

## Energy-saving Model

Application examples:
Cutting chip removal
Pressure: 0.5 MPa*1
Nozzle size: ø10
Removal time (1 operation): 0.1 s
Air consumption: 0.6 L (ANR)

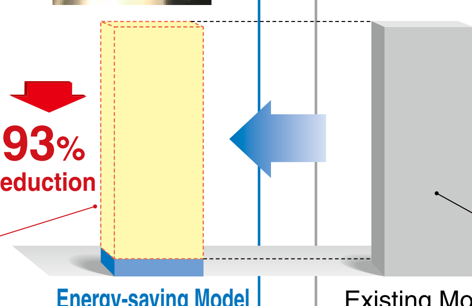
*1 The removal of cutting chips caught up in the blades



When operating for 2500 hours/year, 60 removal operations/hour

**90 m³/year (ANR)**
$CO_2$ emissions: **5** kg/year
**65** kg reduction in annual $CO_2$ emissions
(**$1**/year)
**($16/year reduction)**

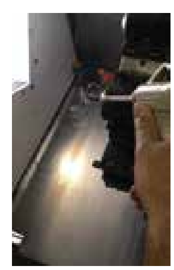
**93% reduction**




## Existing Model

Application examples:
Cutting chip removal
Pressure: 0.5 MPa*1
Nozzle size: ø2
Removal time (1 operation): 4 s
Air consumption: 8 L (ANR)

*1 The removal of cutting chips caught up in the blades



When operating for 2500 hours/year, 60 removal operations/hour

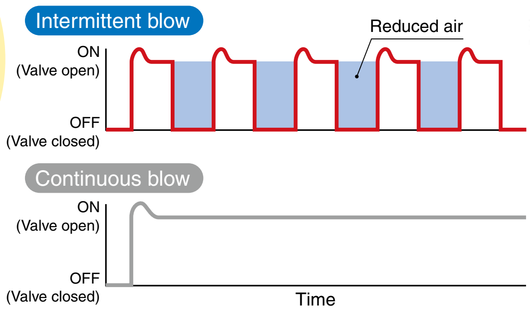
**1200 m³/year (ANR)**
$CO_2$ emissions: **70** kg/year
(**$17**/year)

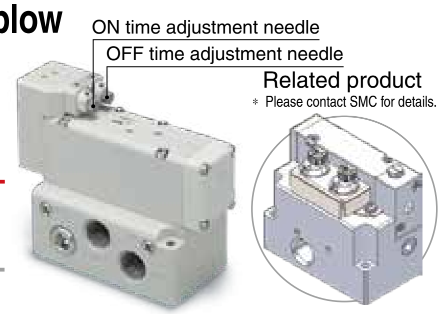
Corresponding value: Air unit $0.014/m³ (ANR), Air – $CO_2$ conversion factor 0.0586 kg/m³ (ANR)

# Pulse Blowing Valve *AXTS* Series

**$CO_2$ emissions (Air consumption)**
**50% reduction**

## Proposal for air-saving air blow by changing from continuous blow to intermittent blow



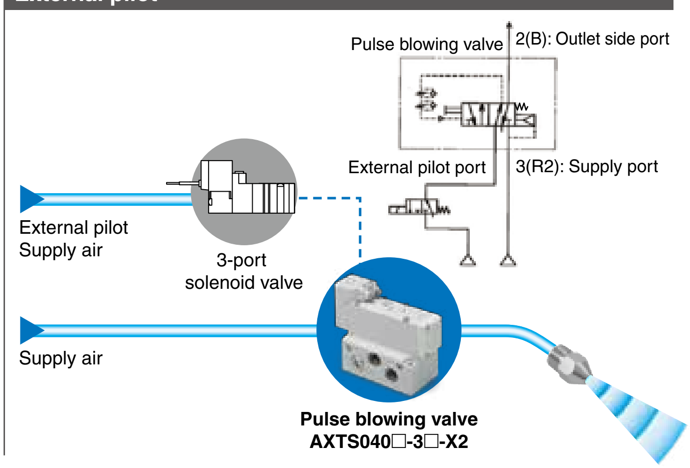




Port size: 1/2
**AXTS040□-□□-X2**

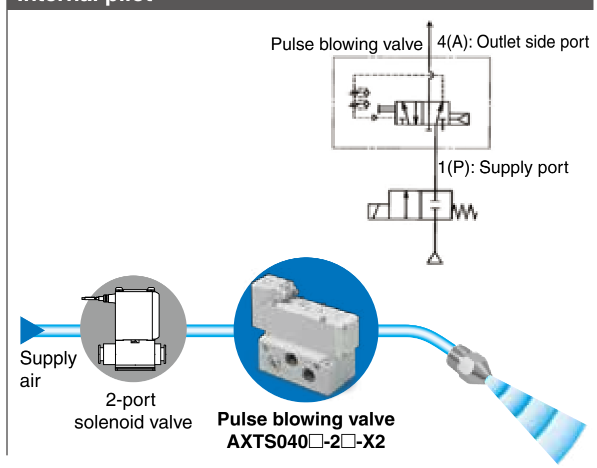
Port size: 1/4
**AXTS020-1P-X2**

## ■ Control for pulse generation is not required. Pulse blow can be used by simply supplying air.

**External pilot**




**Internal pilot**




## ■ Long service life (200 million cycles or more)

## ■ ON/OFF time adjustable individually

## ■ Operating pressure range: 0.2 to 1.0 MPa

## ■ Flow rate characteristics

| Type of actuation | C [dm³/(s·bar)] | b | Cv |
|---|---|---|---|
| External pilot | 14 | 0.18 | 3.4 |
| Internal pilot | 12 | 0.14 | 2.9 |

### Effects of Energy Saving

**Energy-saving Model**

Changing to pulse air blow

Flow rate per nozzle:
**142.5 L/min (ANR)**

Blow time: 2 sec. (Duty 50%)
Annual operating cycles: 900000

**4275 m³/year (ANR)**
$CO_2$ emissions: **251** kg/year
**250** kg reduction in annual $CO_2$ emissions

(**$60**/year)
**($60/year reduction)**
* Per nozzle

**Existing Model**

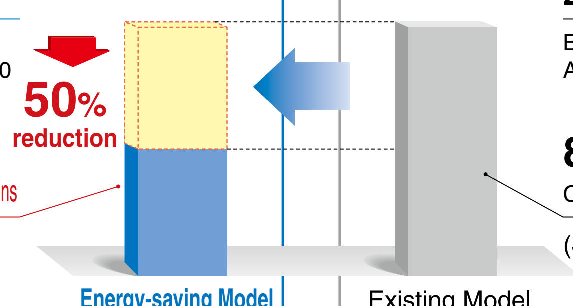
Air blow accounts for 50% of all air consumption

Flow rate per nozzle:
**285 L/min (ANR)**

Blow time: 2 sec
Annual operating cycles: 900000

**8550 m³/year (ANR)**
$CO_2$ emissions: **501** kg/year

(**$120**/year)




Corresponding value: Air unit $0.014/m³ (ANR), Air – $CO_2$ conversion factor 0.0586 kg/m³ (ANR)

# 3 Reduce air leakage



**UNIT CONVERSIONS**

| | unit | conversion | result |
|---|---|---|---|
| length | m | x 3.28 | ft |
| | mm | x 0.04 | in |
| mass | g | x 0.04 | oz |
| volume | $cm^3$ | ÷ 16.387 | $in^3$ |
| | L | x 61.024 | $in^3$ |
| speed | mm/s | ÷ 25.4 | in/s |
| pressure | MPa | x 145 | psi |
| | kPa | ÷ 6.895 | psi |
| temperature | °C | x1.8 then add 32 | °F |
| torque | N·m | x 0.738 | ft-lb |
| force | N | ÷ 4.448 | lbf |
| flow | L/min | ÷ 28.317 | cfm |
| | JPY | x 0.0094 | dollar |

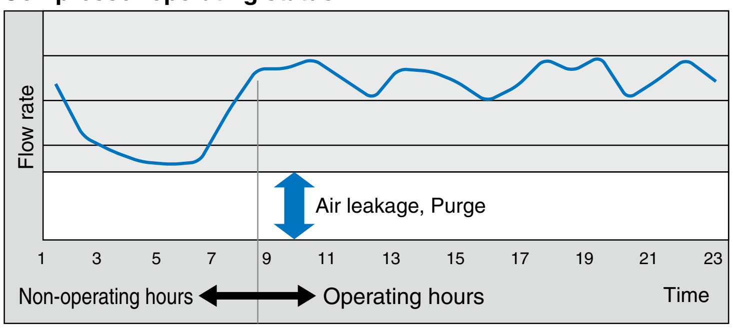
# Air leakage

## Stops leakage from piping equipment

### Before improvement

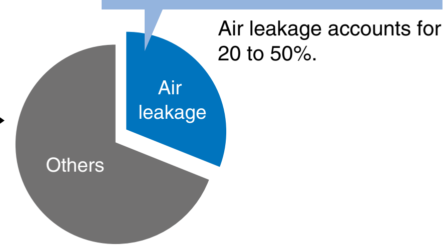
Leaked air actually accounts for 20 to 50% of all consumed air.
Regardless of whether equipment is being operated or not, as the compressor is continually operated, a certain amount of air is consumed and leaked from piping equipment.

**Compressor operating status**



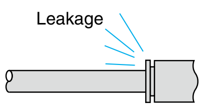

**Air usage**

| | |
|---|---|
| Tubing, Fittings | 20% |
| Coupling fittings | 25% |
| Rubber hose | 30% |
| Others | 25% |

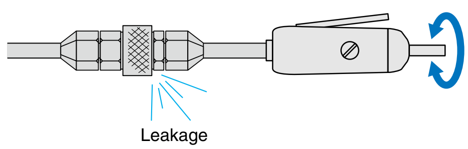



### Air leakage examples

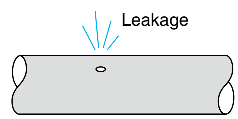
Air leakage from One-touch fittings due to poorly cut tubes




Air leakage from coupling fittings due to poor sealing



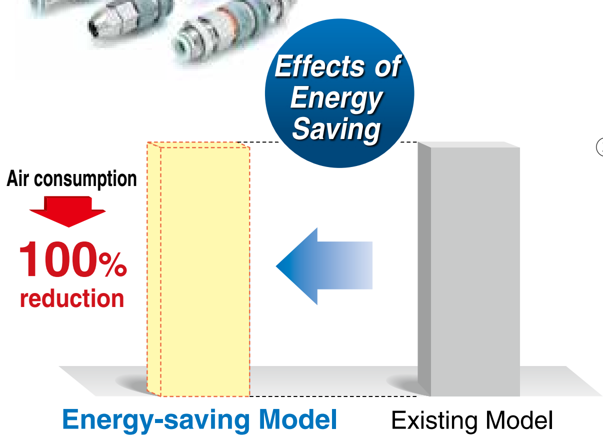

Air leakage from tubes due to cutting chips, wear, spatter, etc.




### After improvement

①Selection of equipment with minimal leakage

**S Coupler**
**KK Series**

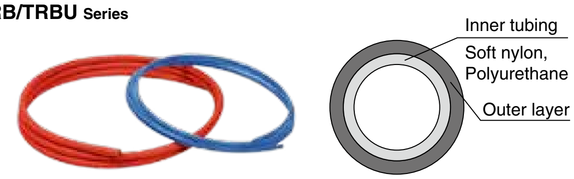

②Adjustment of tube cut surfaces with a dedicated tool

**Tube Cutter**
**TK Series**

**Double Layer Tube Stripper**
**TKS Series**

③Adoption of double layer tubing to prevent tube damage due to cutting chips, spatter, and wear

**Double Layer Tubing**
**TRB/TRBU Series**



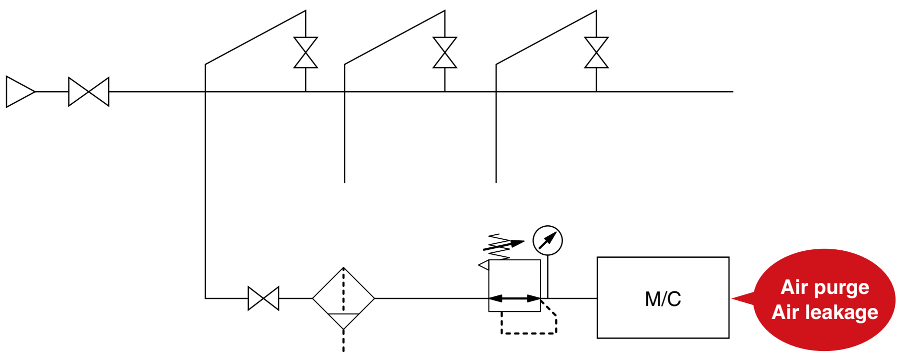

**Sectional view of FR double layer tubing**

# Reducing leakage and purge during non-operating hours

## Reducing air leakage and amount of air used for air purge during non-operating hours of equipment

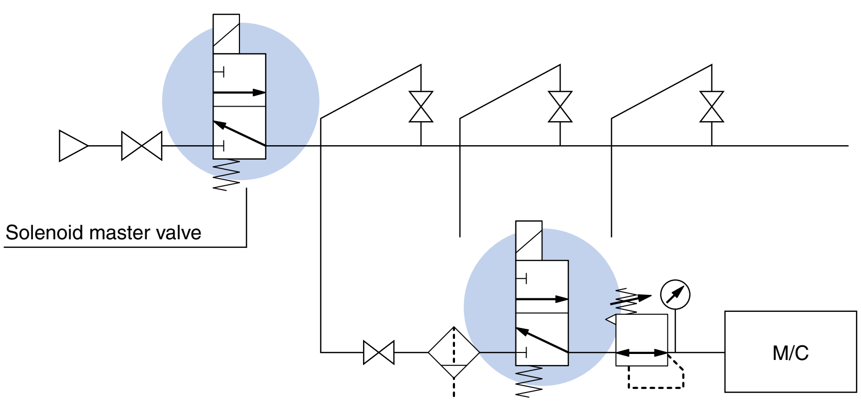
**Before improvement**

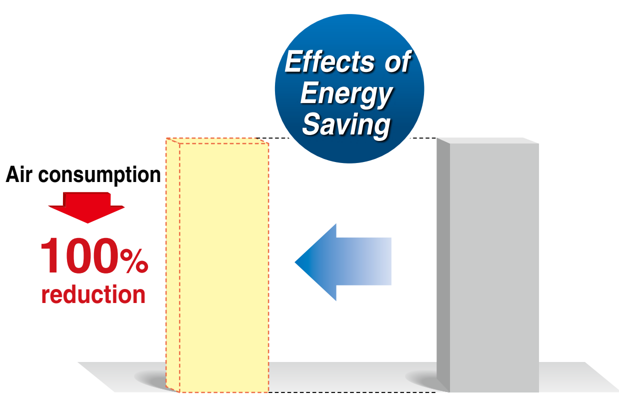
As the compressor is continually operated even during non-operating hours of equipment, it continues to consume air through air leakage, air purge, etc.




**After improvement**

Stop the supply of air during non-operating hours of equipment.




### Installation of a solenoid master valve in each line and for each piece of equipment

Pilot Operated 2-Port Solenoid Valve
**VXD21/22/23 Series**

Pilot Operated 3-Port Solenoid Valve
**VG342 Series**

Pilot Operated 3-Port Solenoid Valve
**VP3145/3165/3185 Series**

# 4 Reduce pressure loss



**UNIT CONVERSIONS**

| | unit | conversion | result |
|---|---|---|---|
| length | m | x 3.28 | ft |
| | mm | x 0.04 | in |
| mass | g | x 0.04 | oz |
| volume | $cm^3$ | ÷ 16.387 | $in^3$ |
| | L | x 61.024 | $in^3$ |
| speed | mm/s | ÷ 25.4 | in/s |
| pressure | MPa | x 145 | psi |
| | kPa | ÷ 6.895 | psi |
| temperature | °C | x1.8 then add 32 | °F |
| torque | N·m | x 0.738 | ft-lb |
| force | N | ÷ 4.448 | lbf |
| flow | L/min | ÷ 28.317 | cfm |
| | JPY | x 0.0094 | dollar |

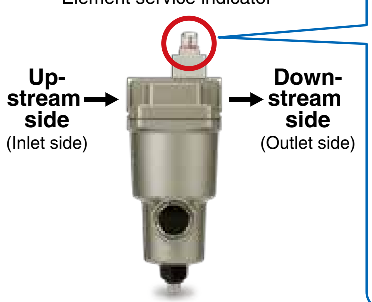
# 4 Reduce pressure loss | Monitoring of air filter clogging

As the air filter processes the compressed air, the element will gradually become clogged, resulting in a pressure drop. Failure to rectify the situation will result in energy loss and reduced actuator output. Therefore, be sure to periodically replace the air filter element before it becomes clogged.

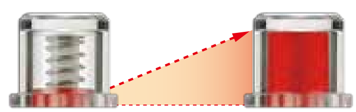
## Clogging indicator

The air filter element needs to be replaced every 2 years or before the pressure drop reaches 0.1 MPa. Confirm the pressure drop due to clogging with the element service indicator, a differential pressure switch, or a differential pressure gauge.

Element service indicator

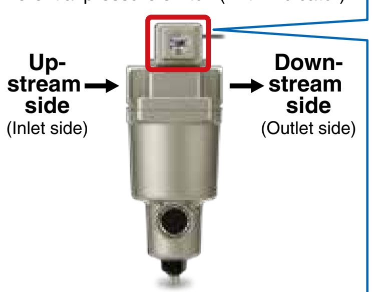



**Replace the element**
when **the red indicator reaches the top**.

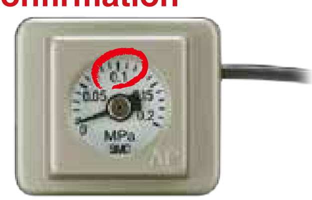


When the differential air is 0.05 MPa → When the differential air is **0.1 MPa**

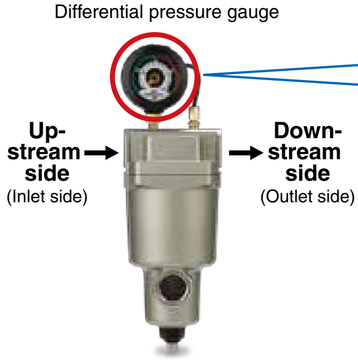
Differential pressure switch (With indicator)




- Confirm the differential pressure by **electrical signal**.
- With an indicator for easy **visual confirmation**



Differential pressure gauge



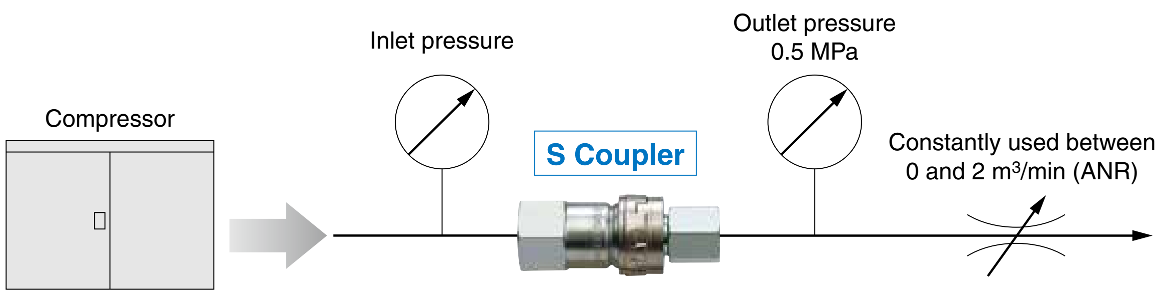

**Replace the element**
when **the needle enters the red zone**
(Differential pressure of **0.1 MPa** or more).

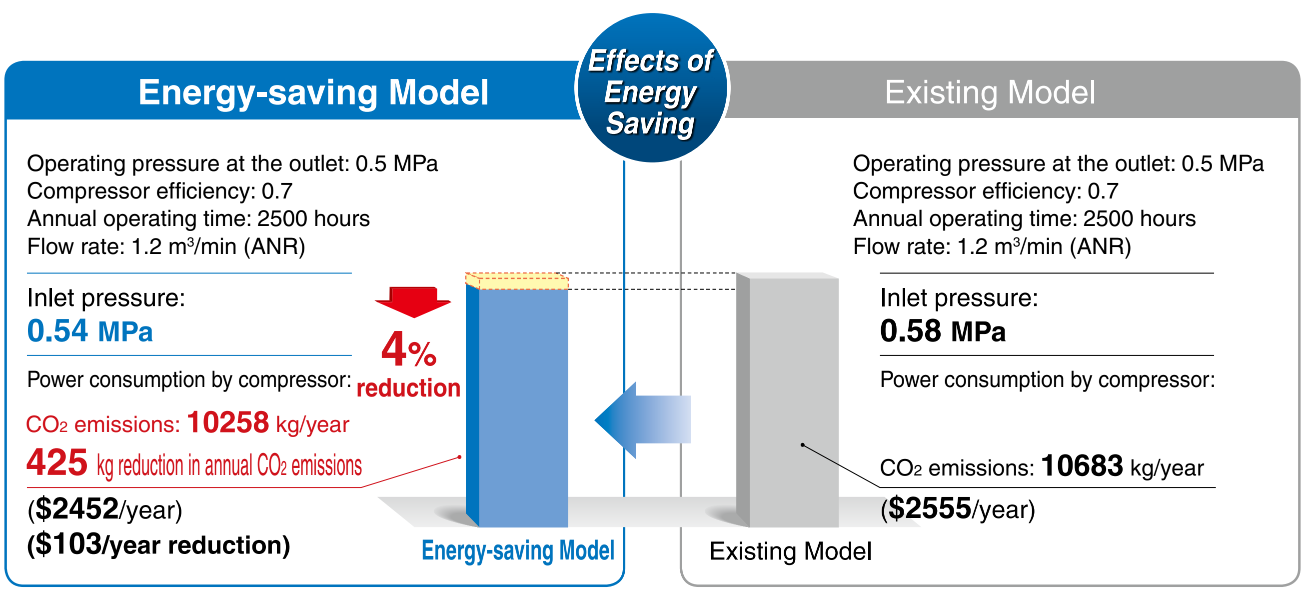
# For reducing pressure loss in lines
# S Couplers *KK130 Series*

**$CO_2$ emissions (Pressure loss)**

**4% reduction**

## The built-in valve is of a special shape, resulting in reduced pressure loss.

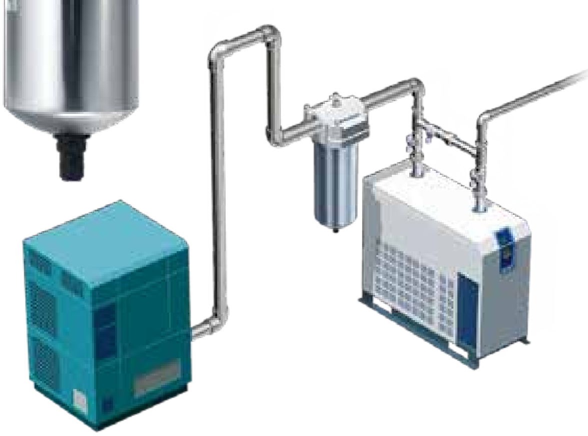



Corresponding value: Electricity unit $0.014/kWh, Power consumption – $CO_2$ conversion factor 0.587 kg – $CO_2$/kWh

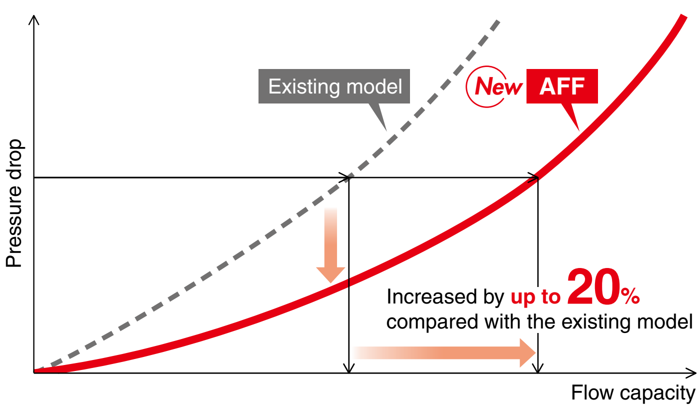
# Main Line Filter *AFF* Series

**Flow Capacity**
**20% increase**



**Flow capacity: 14.5 m³/min (ANR)**
**Pressure drop: 5 kPa or less**

For **AFF90D**




**Reduction in pressure drops! Increased air flow capacity!**

| Size | Filtration | Port size | Flow capacity m³/min (ANR) |
|---|---|---|---|
| **AFF70D** | 1 µm*1 | 1, 1 1/2 | 7.0 / 6.0 **AFF37B** (Existing model) |
| **AFF80D** | | 1 1/2 | 11.0 |
| **AFF90D** | | 1 1/2, 2 | 14.5 / 12.0 **AFF75B** (Existing model) |

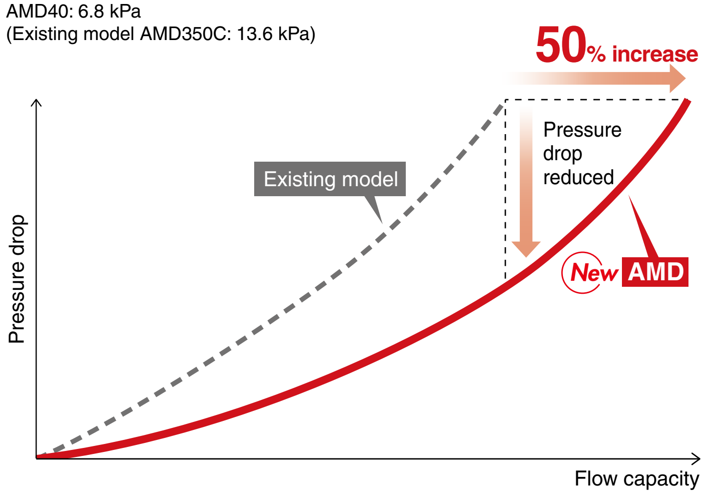
*1 ISO 8573-4: 2010 compliant

## Modular Connection Type
# Micro Mist Separator *AMD Series*

**Flow Capacity**
**50% increase**

**Flow capacity: 1.5 m³/min (ANR)**
**Pressure drop: 6.8 kPa or less**

AMD40: 6.8 kPa
(Existing model AMD350C: 13.6 kPa)




**Reduction in pressure drops! Increased air flow capacity!**

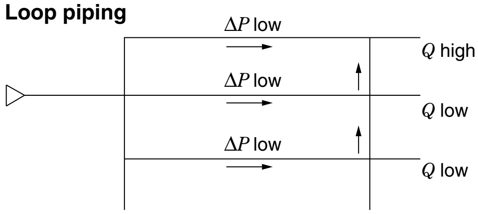
| Size | Filtration | Port size | Flow capacity m³/min (ANR) |
|---|---|---|---|
| **AMD20** | 0.01 µm*1 | 1/8, 1/4 | 0.3<br>0.2 **AMD150C** (Existing model) |
| **AMD30** | 0.01 µm*1 | 1/4, 3/8 | 0.75<br>0.5 **AMD250C** (Existing model) |
| **AMD40** | 0.01 µm*1 | 1/4, 3/8, 1/2 | 1.5<br>1.0 **AMD350C** (Existing model) |

*1 ISO 8573-4: 2010 compliant

# 4 Reduce pressure loss | Leveling of the line pressure

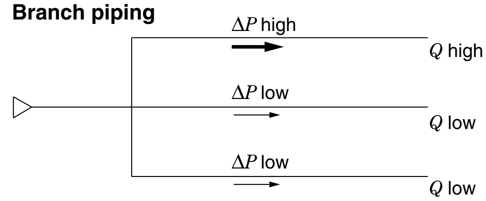
**Uneven terminal pressure in branch piping can be leveled by adopting loop piping, resulting in a reduction in pressure drops.**

**Loop piping**




Leveling of terminal pressure

**Branch piping**




Uneven terminal pressure

Air can be supplied from both sides with loop piping.

▼

Terminal pressure is leveled.

▼

The discharge pressure setting can be lowered.

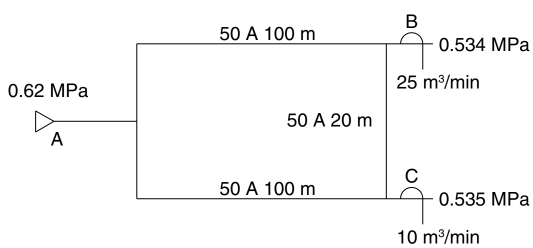
An unbalanced consumption flow rate can lead to a large pressure drop in the line on one side.

▼

Set the discharge pressure high.

**Effects of Energy Saving**

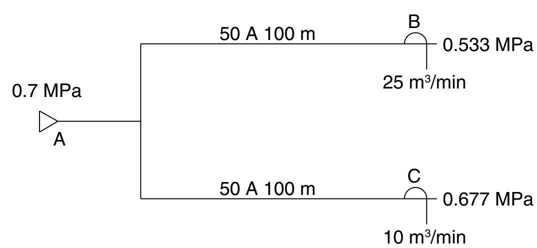
## Energy-saving Circuit




**Pressure drop between A and B: 0.086 MPa**

Operating hours 2000 hours/year

## Existing Circuit




**Pressure drop between A and B: 0.167 MPa**

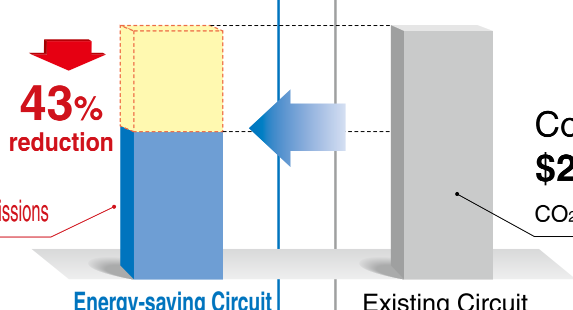
Operating hours 2000 hours/year

Cost of electricity
**$1397**/year

$CO_2$ emissions: 5843 kg/year

**4368** kg reduction in annual $CO_2$ emissions

**($1045/year reduction)**




Cost of electricity
**$2442**/year

$CO_2$ emissions: **10211** kg/year

Corresponding value: Electricity unit $0.014/kWh, Power consumption – $CO_2$ conversion factor 0.587 kg - $CO_2$/kWh

# 5 Air pressure source efficiency



**UNIT CONVERSIONS**

| | unit | conversion | result |
|---|---|---|---|
| length | m | x 3.28 | ft |
| | mm | x 0.04 | in |
| mass | g | x 0.04 | oz |
| volume | $cm^3$ | ÷ 16.387 | $in^3$ |
| | L | x 61.024 | $in^3$ |
| speed | mm/s | ÷ 25.4 | in/s |
| pressure | MPa | x 145 | psi |
| | kPa | ÷ 6.895 | psi |
| temperature | °C | x1.8 then add 32 | °F |
| torque | N·m | x 0.738 | ft-lb |
| force | N | ÷ 4.448 | lbf |
| flow | L/min | ÷ 28.317 | cfm |
| | JPY | x 0.0094 | dollar |

# 5 Air pressure source efficiency | Reducing the specific power of the compressor

**$CO_2$ emissions**
**(Power consumption)**
**8% reduction**

## Power consumption can be reduced by reducing the discharge pressure, intake resistance, and intake temperature.

The discharge pressure, intake pressure, and intake temperature, as well as the number of compression stages, etc., all have an effect on the compressor's specific power. Therefore, in order to reduce the compressor's specific power, the discharge pressure, intake resistance, and intake temperature must all be reduced as well.

## Calculating the specific power of the compressor

The specific power can be calculated from the theoretical shaft power as shown in the equation on the right.
For the specific power, the smaller the value, the greater the efficiency.

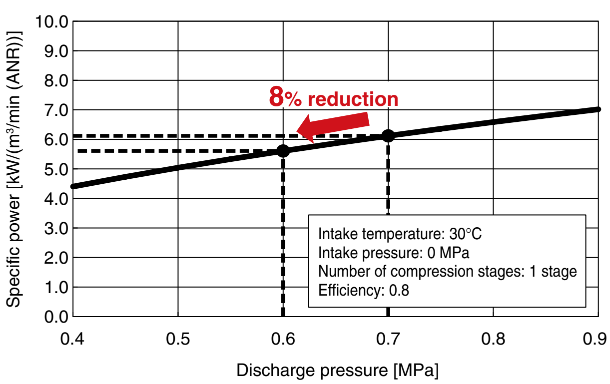
$$L = \frac{m\kappa}{\kappa - 1} \cdot \frac{0.1Q}{0.06\eta} \cdot \frac{273 + T}{293} \times \left\{ \left[ \frac{p_d + 0.1}{p_s + 0.1} \right]^{\frac{\kappa - 1}{m\kappa}} - 1 \right\}$$

$$r = \frac{L}{Q}$$

$L$: theoretical shaft power [kW], $r$: specific power [kW/(m$^3$/min (ANR))], $Q$: discharge flow [m$^3$/min (ANR)], $p_s$: intake pressure [MPa], $p_d$: discharge pressure [MPa], $T$: intake temperature [°C], $\eta$: efficiency, $m$: number of compression stages, and $\kappa$: specific heat ratio (air = 1.4)

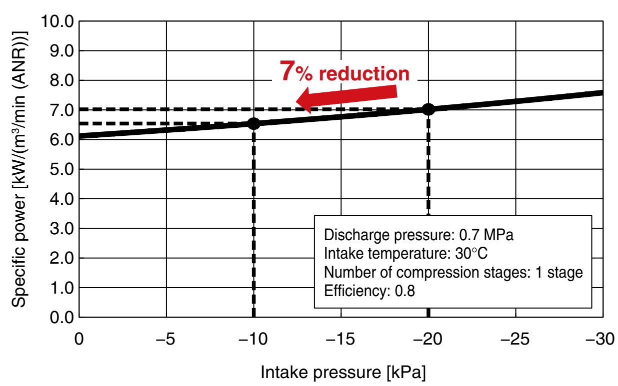
## Effects of the discharge pressure on the specific power

By reducing the discharge pressure from 0.7 MPa to 0.6 MPa, the specific power can be reduced by 8%.



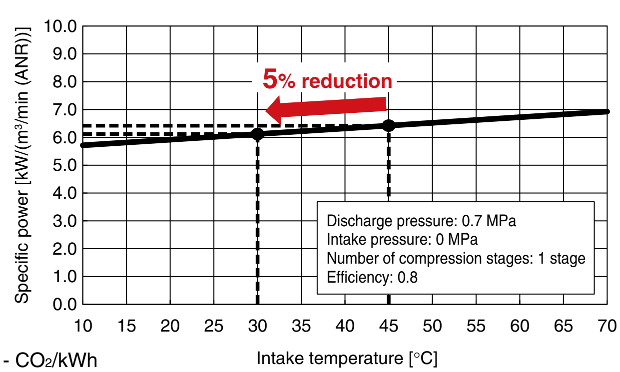

## Effects of the intake pressure on the specific power

By increasing the intake pressure from –20 kPa to –10 kPa, the specific power can be reduced by 7%.




## Effects of the intake temperature on the specific power

By reducing the intake temperature from 45°C to 30°C, the specific power can be reduced by 5%.




Corresponding value: Power consumption – $CO_2$ conversion factor 0.587 kg - $CO_2$/kWh

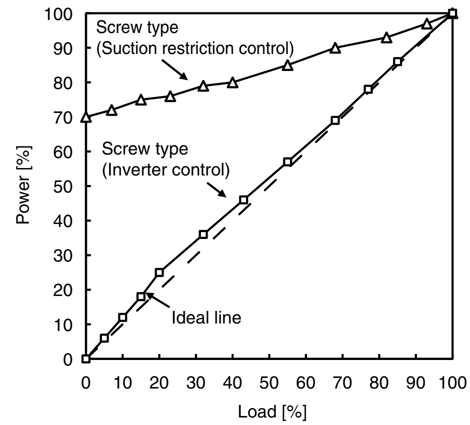
# More efficient compressor operation

**CO₂ emissions (Power consumption)**

**38% reduction**

## Power consumption can be reduced by selecting an optimal operation to deal with load fluctuations.

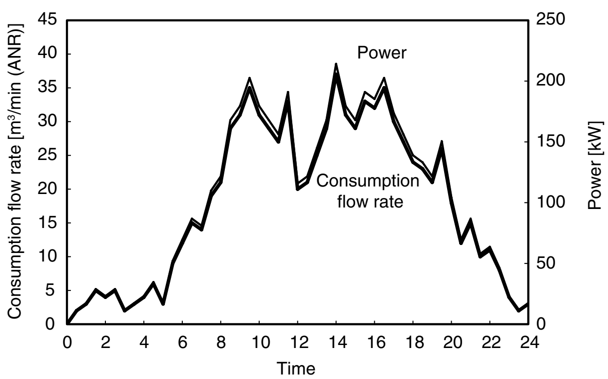
Increased energy efficiency can be realized when the operation selected to deal with and control compressor load (flow rate) fluctuations is optimal.




## Fluctuations in factory air consumption flow rates

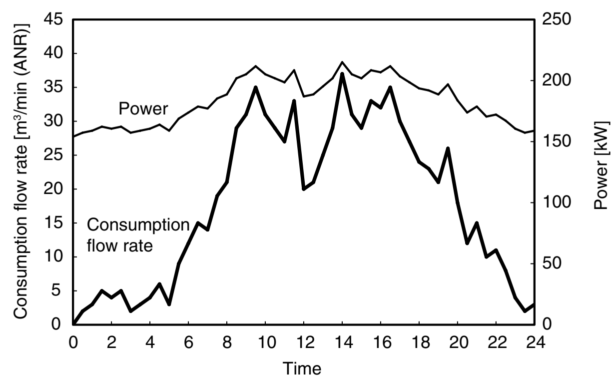
The factory air consumption flow rate (= load) changes depending on the operating state of the equipment. By using inverter control or control for multiple compressors to deal with consumption flow rate fluctuations, compressor energy efficiency can be increased.

### Suitable operation




Inverter control for the control of consumption flow rate fluctuations when multiple compressors are operated

### Before improvement




Open/close control for the control of consumption flow rate fluctuations when 1 compressor is operated

**Effects of Energy Saving**

### Suitable Operation

Base compressor (Screw type)
110 kW, Discharge flow 19 m³/min (ANR)
+
Fluctuation-absorbing compressor (Screw type, Inverter control)
110 kW, Discharge flow 19 m³/min (ANR)
Days of operation per year: 250 days

Annual cost of electricity
**$115,217year**

$CO_2$ emissions: **482162** kg/year

**292678** kg reduction in annual $CO_2$ emissions

**($70,002/year reduction)**

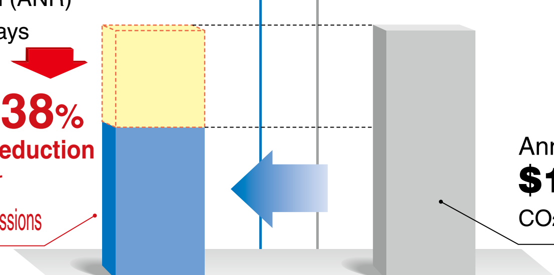
**38% reduction**

### Before Improvement

Compressor (Screw type, Suction restriction control)
220 kW, Discharge flow 40 m³/min (ANR)
Days of operation per year: 250 days

Annual cost of electricity
**$185,173/year**

$CO_2$ emissions: **774840** kg/year



Suitable operation

Before improvement

Corresponding value: Electricity unit $0.014/kWh, Power consumption – $CO_2$ conversion factor 0.587 kg - $CO_2$/kWh

# Booster circuit

**$CO_2$ emissions (Air consumption)**
**33% reduction**

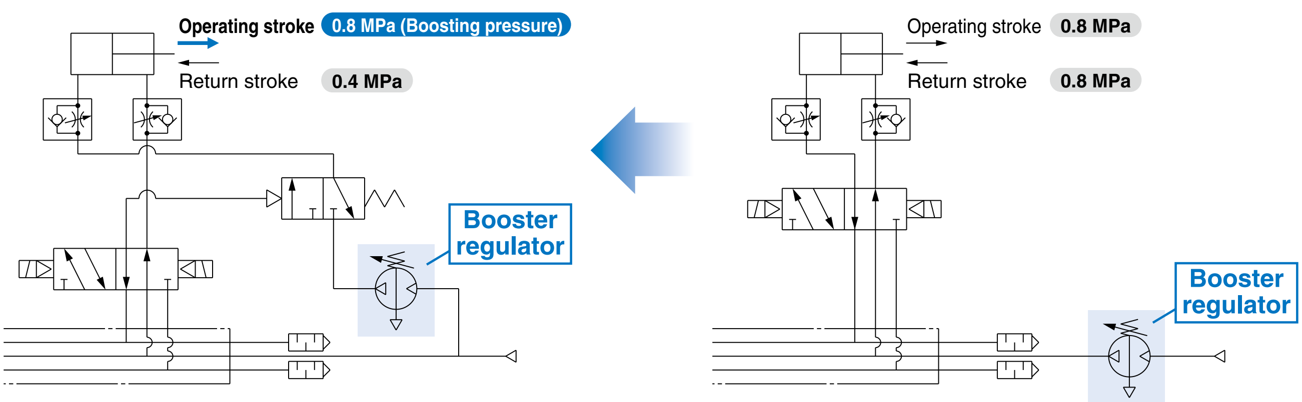
## Air consumption can be reduced by 33% due to the optimization of the booster circuit.


## Boost an insufficiently powered portion with a booster regulator

- Optimized booster circuit: Now with a space-saving booster circuit

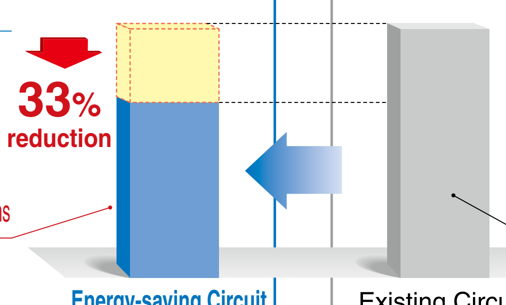
**Example of a one-side booster circuit (Boosting pressure on the operating stroke only)**

**Example of a two-side booster circuit**




### Effects of Energy Saving

| Energy-saving Circuit | Existing Circuit |
|---|---|
| When boosting pressure is on the extension side only<br>Retraction: 0.4 MPa<br>Extension: 0.8 MPa (Boosting pressure) | Bore size: ø50<br>Stroke: 200 mm<br>Pressure: 0.4 MPa<br>Boosting pressure: 0.8 MPa |
| Air consumption:<br>**8.7 L (ANR)/cycle** | Air consumption:<br>**13 L (ANR)/cycle** |
| When it is operated<br>900000 times/year | When it is operated<br>900000 times/year |
| **7830** m³/year (ANR)<br>$CO_2$ emissions: **459** kg/year<br>**227** kg reduction in annual $CO_2$ emissions | **11700** m³/year (ANR)<br>$CO_2$ emissions: **686** kg/year |
| (**$110**/year)<br>**($54/year reduction)** | (**$164**/year) |




Corresponding value: Air unit $0.014/m³ (ANR), Air – $CO_2$ conversion factor 0.0586 kg/m³ (ANR)

# 6 Air/Power saving equipment



**UNIT CONVERSIONS**

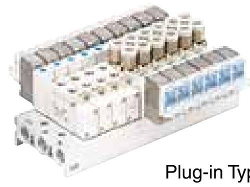
| | unit | conversion | result |
|---|---|---|---|
| length | m | x 3.28 | ft |
| | mm | x 0.04 | in |
| mass | g | x 0.04 | oz |
| volume | $cm^3$ | ÷ 16.387 | $in^3$ |
| | L | x 61.024 | $in^3$ |
| speed | mm/s | ÷ 25.4 | in/s |
| pressure | MPa | x 145 | psi |
| | kPa | ÷ 6.895 | psi |
| temperature | °C | x1.8 then add 32 | °F |
| torque | N·m | x 0.738 | ft-lb |
| force | N | ÷ 4.448 | lbf |
| flow | L/min | ÷ 28.317 | cfm |
| | JPY | x 0.0094 | dollar |

# Low Wattage 3/4/5-Port Solenoid Valve

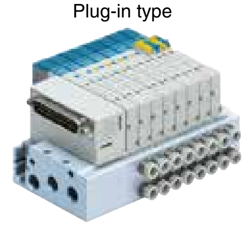
**$CO_2$ emissions (Power consumption)**
**75% reduction**

## The power-saving circuit can reduce the consumption of electric power when the device is energized.

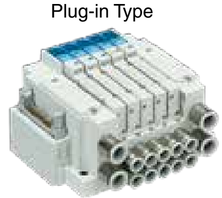
**SY Series**



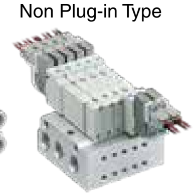
**SY Series**
Plug-in type



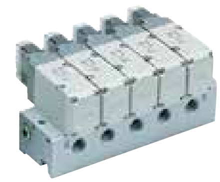
**JSY Series**
Plug-in Type



Non Plug-in Type



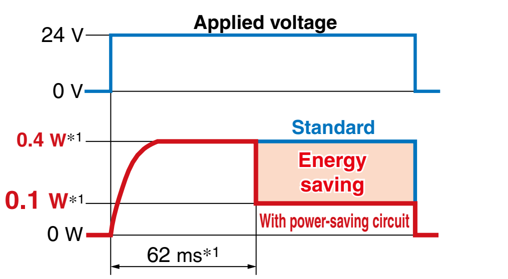
**VP Series**



### • Reduces power consumption when energized

Power consumption can be reduced by approx. 1/4 by reducing the wattage required to hold the valve in an energized state. (Effective energizing time is over 62 ms*1 at 24 VDC.) Refer to the electrical power waveform as shown below.

**Electrical power waveform with power-saving circuit**




*1 SY/SYJ series

### Low Wattage Valve

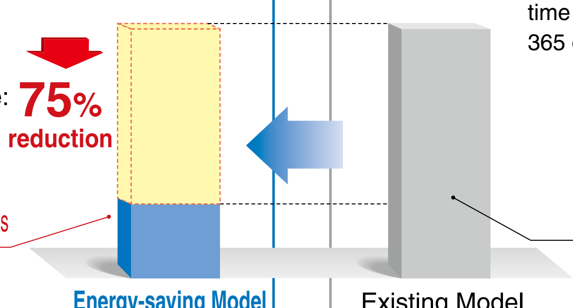
Energy-saving Product

| Type | Model | Power consumption W*2 | |
|---|---|---|---|
| | | Standard | With power-saving circuit |
| 4/5-port | **SJ1000/2000** | 0.55 | 0.23 |
| | **SJ3000** | 0.4 | 0.15 |
| | **New SY3000/5000/7000** | 0.4 | 0.1 |
| | **SY3000/5000/7000** | 0.4 | 0.1 |
| | **JSY1000** | — | 0.2 |
| | **JSY3000/5000** | 0.4 | 0.1 |
| | **SYJ3000/5000/7000** | 0.4 | 0.1 |
| 3-port | **V100** | 0.4 | 0.1 |
| | **SYJ300/500/700** | 0.4 | 0.1 |
| | **VP300/500** | 0.4 | — |
| | **VP700** | 0.55 | 0.55 |

*2 With DC light

### Effects of Energy Saving

| Energy-saving Model | Existing Model |
|---|---|
| **SY: 0.1 W**<br>When the energizing time is 8 hours/day, 365 days/year<br>Power consumption per valve:<br>**292 Wh/year**<br>$CO_2$ emissions: **0.2** kg/year<br>**0.5** kg reduction in annual $CO_2$ emissions<br>(**$0.04**/year)<br>(**$0.12**/year reduction) | **SY:** 0.4 W<br>When the energizing time is 8 hours/day, 365 days/year<br>Power consumption per valve:<br>**1168 Wh/year**<br>$CO_2$ emissions: **0.7** kg/year<br>(**$0.16**/year) |




Corresponding value: Electricity unit $0.014/kWh, Power consumption – $CO_2$ conversion factor 0.587 kg - $CO_2$/kWh

6 Air/Power saving equipment

# Air Cylinder (Intermediary Bore Size) *JMB Series*

**$CO_2$ emissions (Air consumption)**

**29% reduction**

## Air consumption can be reduced by selecting an optimal size air cylinder.

Intermediary Bore Sizes

## Air consumption can be reduced by up to 29%

| Bore size (mm) | ø40 | ø45 | ø50 | ø56 | ø63 | ø67 | ø80 | ø85 | ø100 |
|---|---|---|---|---|---|---|---|---|---|
| Air consumption L/min (ANR) | 1.4 | 1.8 | 2.2 | 2.8 | 3.6 | 4.1 | 5.8 | 6.6 | 9.1 |

Conditions/Supply pressure: 0.5 MPa
Load factor: 50%, At 100 mm stroke

18% reduction (ø50 → ø45)
22% reduction (ø63 → ø56)
29% reduction (ø80 → ø67)
27% reduction (ø100 → ø85)

**Example** Bore size for 85 kg workpieces

Conditions/Supply pressure: 0.5 MPa, Load factor: 50%

| Bore size (mm) | Theoretical output (N) | Output for load factor of 50% (kg) | Judgment |
|---|---|---|---|
| ø63 | 1559 | 79.5 | Not acceptable (Insufficient) |
| ø80 | 2513 | 128.2 | Acceptable (Excessive) |
| When intermediary bore size ø67 is used | | | |
| **ø67** | **1763** | **89.9** | **OK** |

Existing size: ø80
↓
Could be switched to intermediary bore size **ø67**

### Effects of Energy Saving

### Energy-saving Model

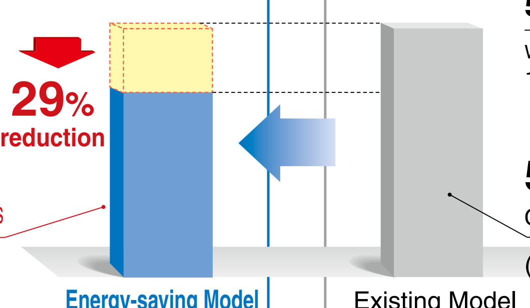
Bore size: ø67
Stroke: 100 mm
Pressure: 0.5 MPa
Load factor: 50%

Air consumption:
**4.1 L (ANR)/cycle**

When it is operated
1000000 times/year

**4100 $m^3$/year (ANR)**
$CO_2$ emissions: **240** kg/year
**100** kg reduction in annual $CO_2$ emissions

(**$58**/year)
**($24/year reduction)**




### Existing Model

Bore size: ø80
Stroke: 100 mm
Pressure: 0.5 MPa
Load factor: 50%

Air consumption:
**5.8 L (ANR)/cycle**

When it is operated
1000000 times/year

**5800 $m^3$/year (ANR)**
$CO_2$ emissions: **340** kg/year

(**$81**/year)

Corresponding value: Air unit \$0.014/$m^3$ (ANR), Air – $CO_2$ conversion factor 0.0586 kg/$m^3$ (ANR)

# Double Power Cylinder *MGZ Series*

**CO2 emissions (Air consumption)**

**14% reduction**

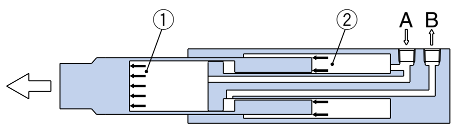
## Air consumption can be reduced by 14% due to the reduced cylinder size.

It is possible to reduce air consumption in the retracting direction, compared with a standard cylinder with equivalent output in the extending direction, due to the doubled piston area in the extending direction.

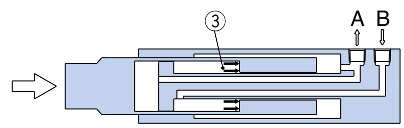
### Double extension output power!

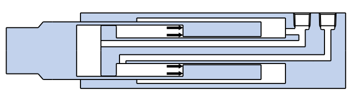
SMC's unique cylinder construction doubles the piston area in the extending direction. This is an ideal air cylinder for lifting and press applications.

Air pressure supplied from A operates on both surfaces ① and ②. (Extension)




Air pressure supplied from B operates on surface ③. (Retraction)



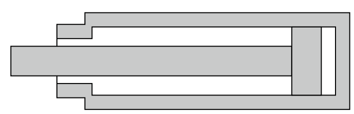



**ø63**

Piston area
Extension: 5945 mm²
Retraction: 2313 mm²

Increased energy saving and space saving
Reduced cylinder size

**Size reduction**
**ø63 ← ø80**



**ø80**

Piston area
Extension: 5030 mm²
Retraction: 4540 mm²

**Effects of Energy Saving**

## Energy-saving Model

Bore size: ø63
Stroke: 200 mm
Pressure on the extension side: 0.5 MPa

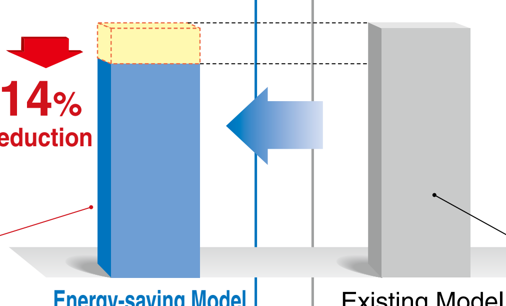
Theoretical output (Extension side): 2973 N
Air consumption:
**9.9 L (ANR)/cycle**

When it is operated
900000 times/year

**8910 m³/year** (ANR)
CO2 emissions: **522** kg/year
**85** kg reduction in annual CO2 emissions

(**$125**/year)
**($20/year reduction)**

**14% reduction**




## Existing Model

Bore size: ø80
Stroke: 200 mm
Pressure: 0.5 MPa

Theoretical output (Extension side): 2520 N
Air consumption:
**11.5 L (ANR)/cycle**

When it is operated
900000 times/year

**10350 m³/year** (ANR)
CO2 emissions: **607** kg/year

(**$145**/year)

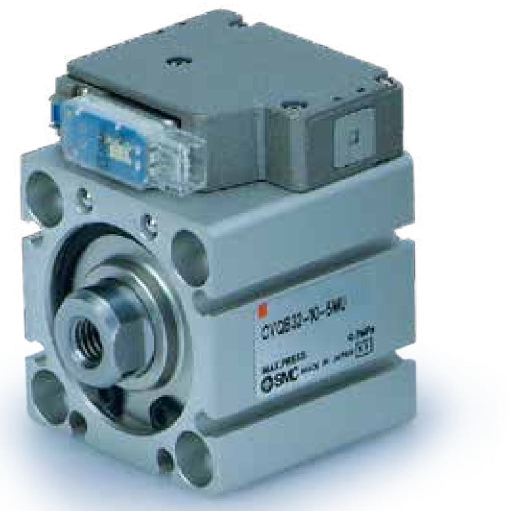
Corresponding value: Air unit $0.014/m³ (ANR), Air – CO2 conversion factor 0.0586 kg/m³ (ANR)

# Compact Cylinder with Solenoid Valve *CVQ Series*

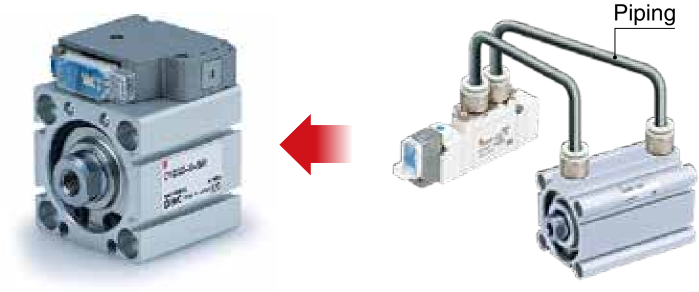
**$CO_2$ emissions (Air consumption)**
**50% reduction**

## Energy Saving

Air consumption between the valve and cylinder can be reduced by approximately **50%**.



### Valve and compact cylinder integrated for compactness




**Effects of Energy Saving**

## Energy-saving Model

Bore size: ø32
Stroke: 30 mm
No piping between the valve and the cylinder
Supply pressure: 0.5 MPa

Air consumption:
**0.25 L (ANR)/cycle**

When it is operated
900000 times/year

**228 m³/year (ANR)**
$CO_2$ emissions: **13** kg/year
**13** kg reduction in annual $CO_2$ emissions

(**$3**/year)
**($3/year reduction)**

## Existing Model

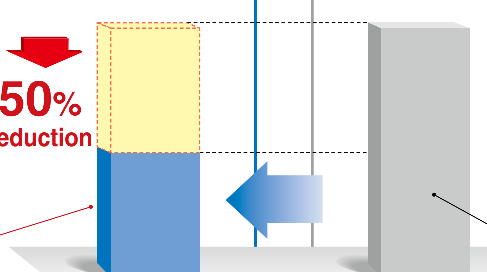
Bore size: ø32
Stroke: 30 mm
Piping bore: 4 mm
Piping length: 2 m
(Between the valve and the cylinder)
Supply pressure: 0.5 MPa

Air consumption:
**0.51 L (ANR)/cycle**

When it is operated
900000 times/year

**455 m³/year (ANR)**
$CO_2$ emissions: **26** kg/year

(**$6**/year)

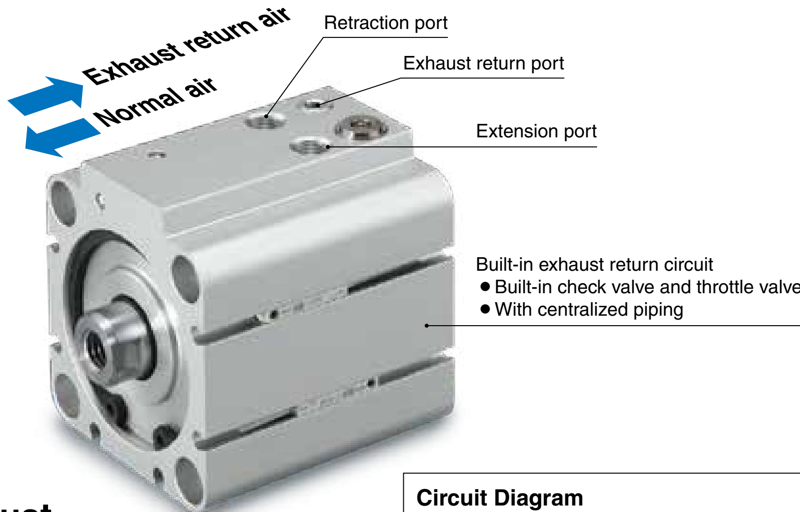



Corresponding value: Air unit $0.014/m³ (ANR), Air – $CO_2$ conversion factor 0.0586 kg/m³ (ANR)

# Compact Cylinder/Air Saving Type *CDQ2B-X3150*

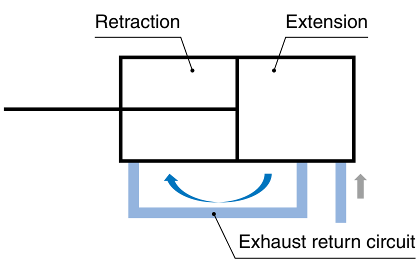
$CO_2$ emissions
(Air consumption)
Max. **46%** reduction

## Reduced air consumption due to the built-in exhaust return circuit

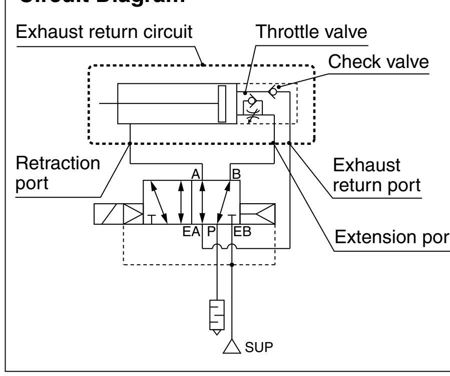



Uses the air exhausted from the working side to supply the non-working side, thus reusing the air

### Reduce air consumption just by piping to the product

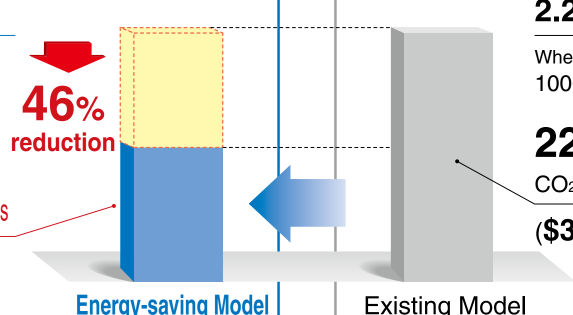



**Circuit Diagram**




**Effects of Energy Saving**

| Energy-saving Model | Existing Model |
|---|---|
| Bore size: ø50<br>Stroke: 100 mm<br>Pressure: 0.5 MPa | Bore size: ø50<br>Stroke: 100 mm<br>Pressure: 0.5 MPa |
| Air consumption per cycle<br>**1.2 L (ANR)** | Air consumption per cycle<br>**2.2 L (ANR)** |
| When it is operated<br>1000000 times/year<br>**1200 m³/year** (ANR)<br>$CO_2$ emissions: **70** kg/year<br>**59** kg reduction in annual $CO_2$ emissions<br>(**$17**/year)<br>**($14/year reduction)** | When it is operated<br>1000000 times/year<br>**2200 m³/year** (ANR)<br>$CO_2$ emissions: **129** kg/year<br>(**$31**/year) |




Corresponding value: Air unit $0.014/m³ (ANR), Air – $CO_2$ conversion factor 0.0586 kg/m³ (ANR)

# Vacuum Ejector ZK2□A Series

**A digital pressure switch for vacuum with an energy-saving function and a more efficient ejector**

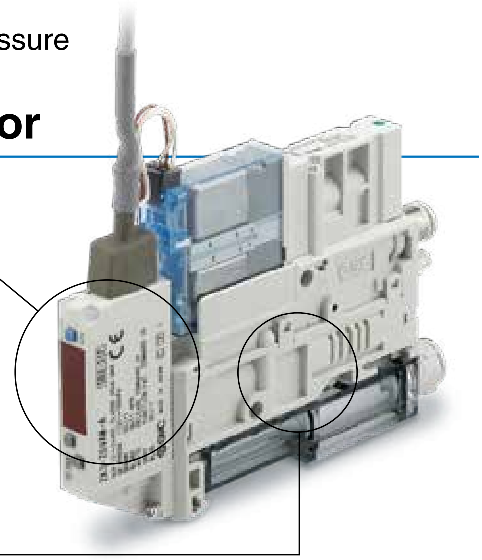
**$CO_2$ emissions (Air consumption)**

**93% reduction***1

*1 Based on SMC's measuring conditions

Cuts off supply air when the pressure reaches the desired vacuum

## Energy saving ejector



### The digital pressure switch with energy-saving function can reduce

**Air consumption 90% reduction***2

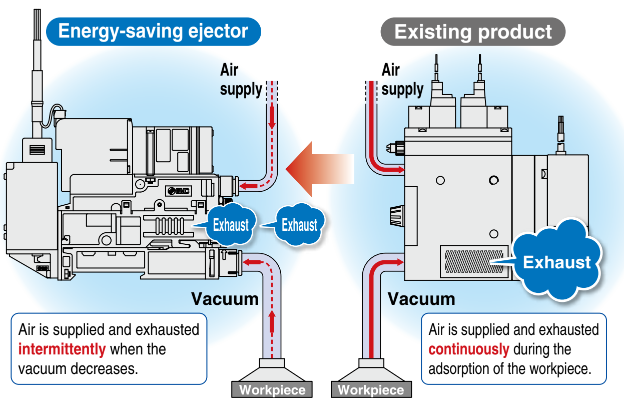
*2 Based on SMC's measuring conditions

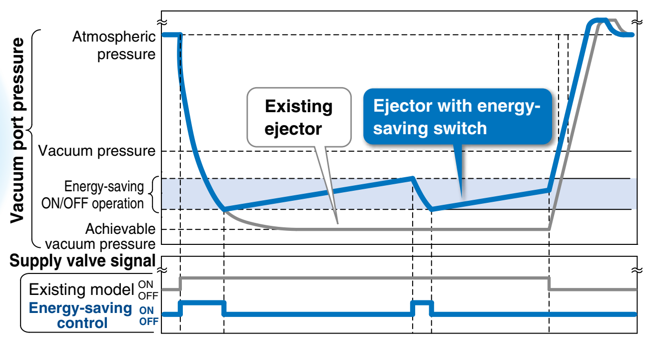
While the suction signal is ON, the ON/OFF operation of the supply valve is also performed automatically within the set value.

### More efficient ejector

**Air consumption 30% reduction**

(Compared to other SMC single stage ejectors)




**Effects of Energy Saving**

## Energy-saving Model

- Air consumption: 58 L/min (ANR)
  Vacuum suction flow rate: 61 L/min (ANR)
- Vacuum generation time: 0.6 s/cycle
  (Vacuum is continuously generated and air is consumed for 6 s (1 cycle))
- Annual operating cycles: 1100000
  (450 cycles/h, 10 h/day, 250 days/year)

Air consumption (When placed):
**58 L/min (ANR)**

**638 m³/year** (ANR)
$CO_2$ emissions: **37** kg/year
**511** kg reduction in annual $CO_2$ emissions

(**$9**/year)
**($122/year reduction)**

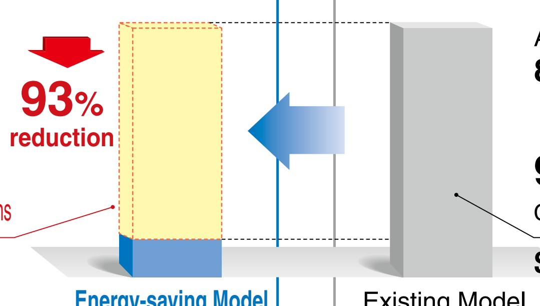
## Existing Model

- Air consumption: 85 L/min (ANR)
  Vacuum suction flow rate: 44 L/min (ANR)
- Vacuum generation time: 6 s/cycle
  (Vacuum is continuously generated and air is consumed for 6 s (1 cycle))
- Annual operating cycles: 1100000
  (450 cycles/h, 10 h/day, 250 days/year)

Air consumption (When placed):
**85 L/min (ANR)**

**9350 m³/year** (ANR)
$CO_2$ emissions: **548** kg/year

**$131**/year)




Corresponding value: Air unit \$0.014/m³ (ANR), Air – $CO_2$ conversion factor 0.0586 kg/m³ (ANR)

# Multistage Ejector *ZL3* Series

**CO2 emissions (Air consumption)**

**91% reduction**[*1]

*1 Based on SMC's measurement conditions When equipped with a pressure switch for vacuum with energy saving function (ZL3)

Pressure switch for vacuum with energy saving function

**Air consumption**

**90% reduction**

More efficient ejector

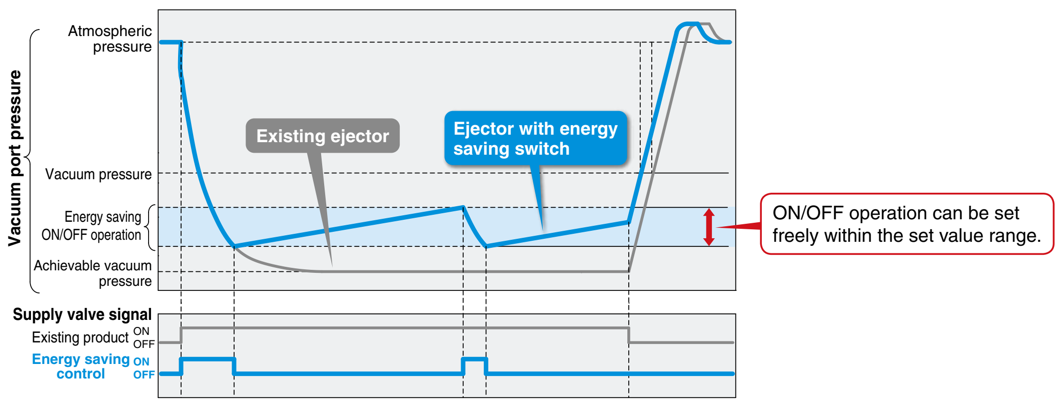
**Air consumption**

**10% reduction**

(Compared to ZL212)

**Energy saving is possible due to the pressure switch for vacuum with energy saving function.**

Even when the suction signal is ON, the ON/OFF operation of the supply valve is performed automatically within the set value.




## Effects of Energy Saving

### Energy-saving Model

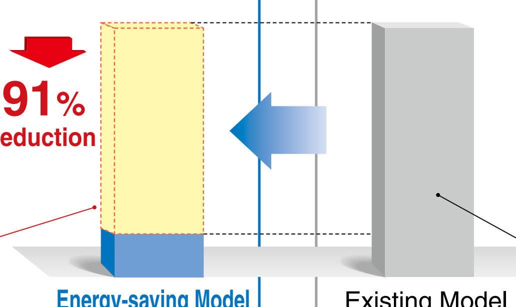
- Air consumption: 135 L/min (ANR)
  Vacuum suction flow rate: 300 L/min (ANR)
- Vacuum generation time: 1.5 s/cycle
  (Air is only consumed for 1.5 s per cycle (15 s) during workpiece adsorption.)
- Annual operating cycles: 300000
  (120 cycles/h, 10 h/day, 250 days/year)

Air consumption (When placed):
**3.4 L/cycle (ANR)**

**1013 m³/year (ANR)**
$CO_2$ emissions: **60** kg/year
**606** kg reduction in annual $CO_2$ emissions

(**$14**/year)
**($144/year reduction)**

**91% reduction**




### Existing Model

- Air consumption: 150 L/min (ANR)
  Vacuum suction flow rate: 250 L/min (ANR)
- Vacuum generation time: 15 s/cycle
  (Vacuum is continuously generated and air is consumed for 15 s (1 cycle))
- Annual operating cycles: 300000
  (120 cycles/h, 10 h/day, 250 days/year)

Air consumption (When placed):
**37.5 L/cycle (ANR)**

**11250 m³/year (ANR)**
$CO_2$ emissions: **666** kg/year

(**$158**/year)

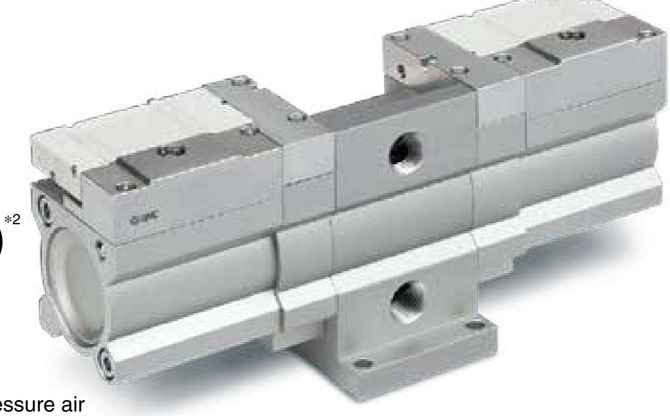
Corresponding value: Air unit $0.014/m³ (ANR), Air – $CO_2$ conversion factor 0.0586 kg/m³ (ANR)

# Booster Regulator *VBA-X3145*

CO2 emissions (Air consumption)
**40% reduction**[*1]

*1 Based on SMC's measuring conditions

- **3 piston construction**
- **The drive chamber on one side can be operated by the exhaust return circuit.**

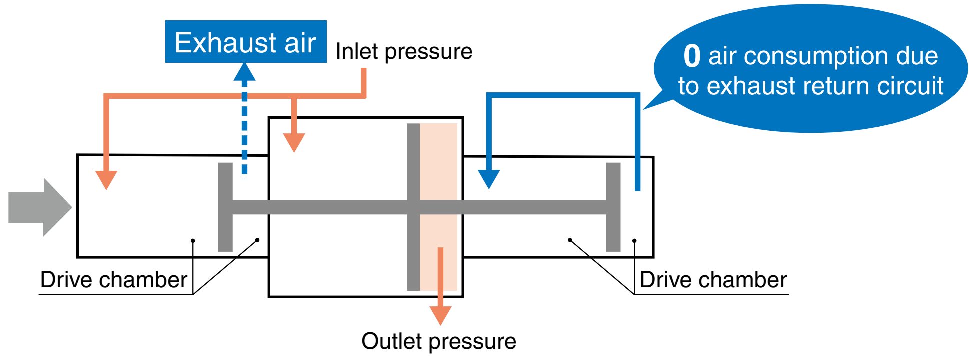


## Operation noise: 65 dB(A)[*2]

*2 Based on SMC's measuring conditions

### 15 dB (A) reduction compared with the existing model (VBA series)

- Exhaust noise: Reduced noise due to exhaust of reused low-pressure air
- Metal noise: Reduced noise due to the adoption of a construction in which the internal switching part doesn't come into contact with any metal parts



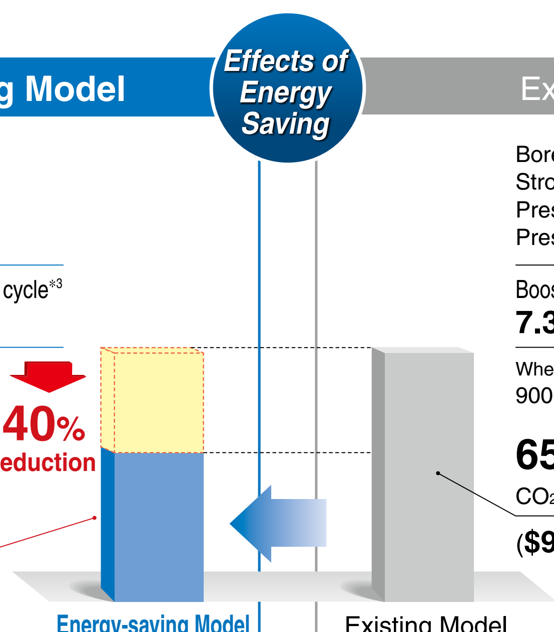

## Energy-saving Model

Bore size: ø50
Stroke: 200 mm
Pressure: 0.47 MPa
Pressure increase: 0.8 MPa

Booster regulator air consumption per cycle[*3]
**4.4 L (ANR)**

When it is operated 900000 times/year
**3960 $m^3$/year (ANR)**
$CO_2$ emissions: **232** kg/year
**153** kg reduction in annual $CO_2$ emissions

(**$56**/year)
**($37/year reduction)**




## Existing Model

Bore size: ø50
Stroke: 200 mm
Pressure: 0.47 MPa
Pressure increase: 0.8 MPa

Booster regulator air consumption per cycle[*3]
**7.3 L (ANR)**

When it is operated 900000 times/year
**6570 $m^3$/year (ANR)**
$CO_2$ emissions: **385** kg/year

(**$92**/year)

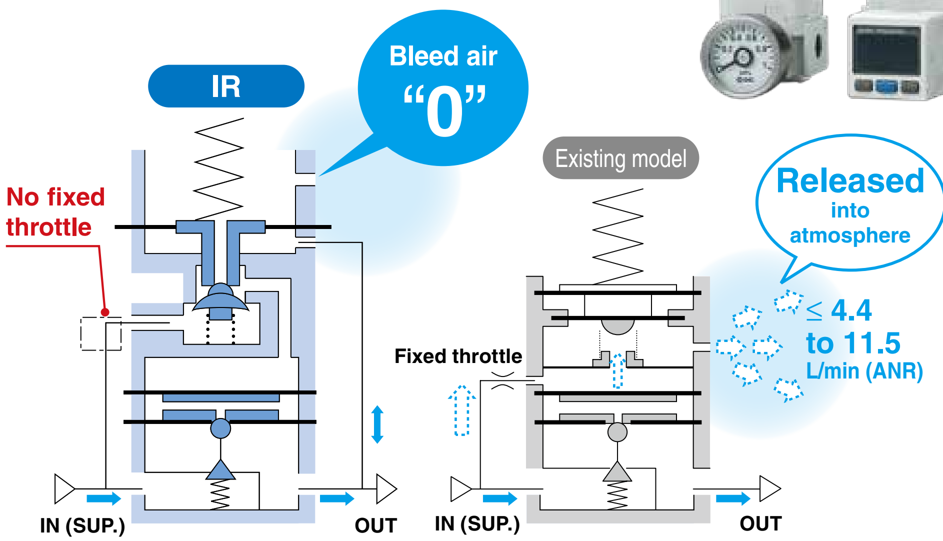
Corresponding value: Air unit $0.014/$m^3$ (ANR), Air – $CO_2$ conversion factor 0.0586 kg/$m^3$ (ANR)
*3 Air consumption = Inlet flow rate – Outlet flow rate

Air consumption

# Bleed air "0"

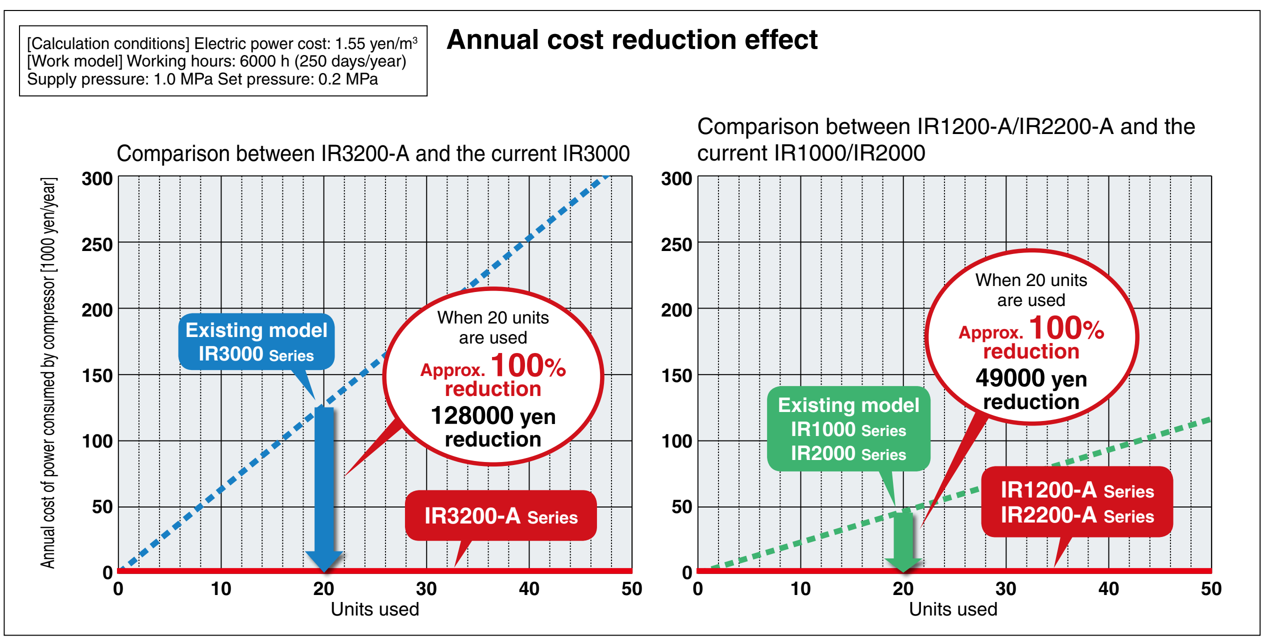
## Air consumption is reduced with a new original structure.

With this new original structure,
running costs are reduced.




## ● No fixed throttle in the new design.

* Poor quality of air may cause operation failure. Select a model that is suitable for the desired air cleanliness by referring to "Air Preparation Equipment Model Selection Guide" for air quality.



# Air Saving Speed Controller *AS-R Series*

$CO_2$ emissions (Air consumption)

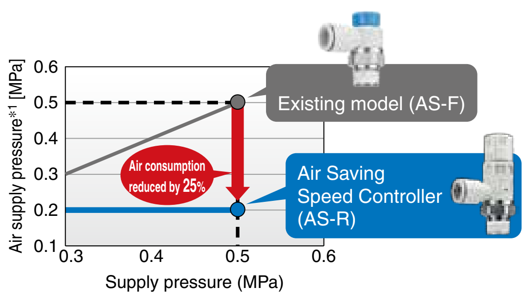
**25% reduction**

## Reduce air consumption just by mounting to your current air cylinder!

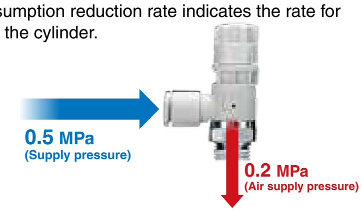
Mounting and operation are the same as a regular speed controller.

With pressure-reduction function
**AS-R Series**

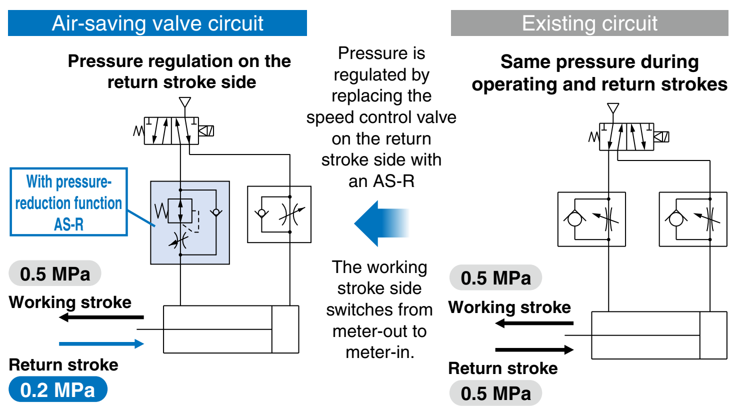
By reducing the pressure on the return stroke to 0.2 MPa, air consumption can be reduced.




*1 Cylinder pressure on the return stroke side
* The air consumption reduction rate indicates the rate for one cycle of the cylinder.




When it is not necessary to apply force at the end of the working stroke, by using a lifter, pusher, etc.




## Effects of Energy Saving

### Energy-saving Model

Bore size: ø50
Stroke: 200 mm
Pressure on the extension side: 0.5 MPa
Pressure on the retraction side: 0.2 MPa

Air consumption:
**3.5 L (ANR)/cycle**

When it is operated
900000 times/year

**3150 m³/year (ANR)**
$CO_2$ emissions: **185** kg/year
**63** kg reduction in annual $CO_2$ emissions

(**$44**/year)
**($15/year reduction)**

### Existing Model

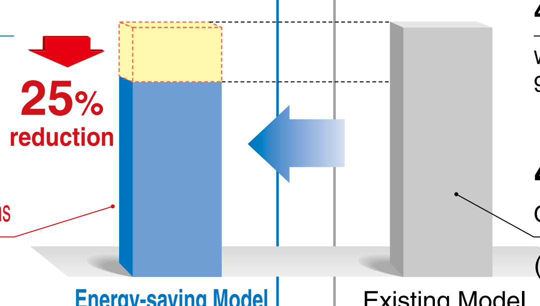
Bore size: ø50
Stroke: 200 mm
Pressure: 0.5 MPa

Air consumption:
**4.7 L (ANR)/cycle**

When it is operated
900000 times/year

**4230 m³/year (ANR)**
$CO_2$ emissions: **248** kg/year

(**$59**/year)



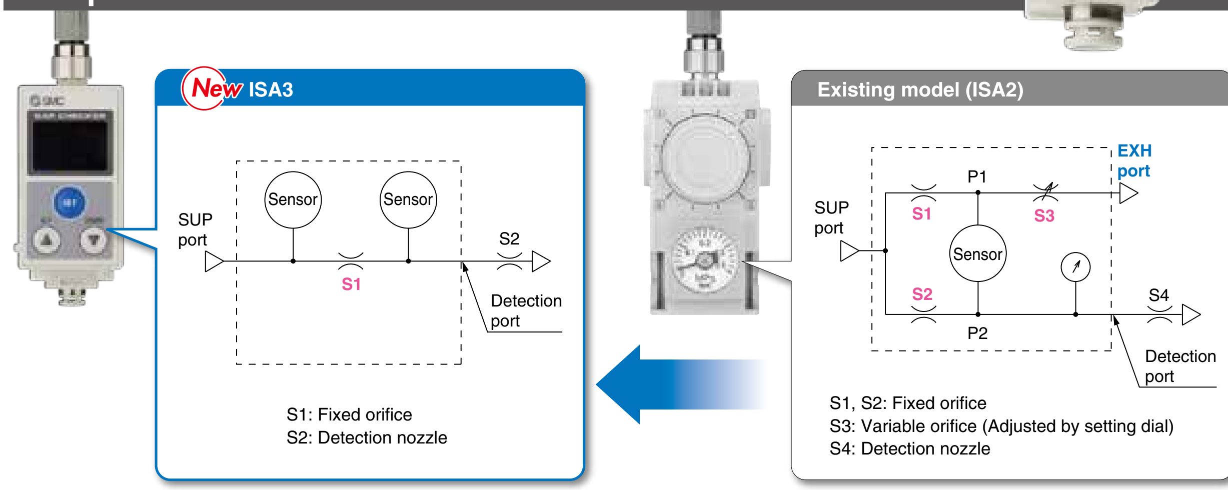

Corresponding value: Air unit $0.014/m³ (ANR), Air – $CO_2$ conversion factor 0.0586 kg/m³ (ANR)

# Digital Gap Checker *ISA3 Series*

**CO2 emissions**
(Air consumption)
**60% reduction**

## Air consumption when a workpiece is seated is now 0 L/min due to the new detection principle.


## Comparison of detection circuit




Due to the new detection principle, the need for air to be exhausted from the product has been eliminated. This makes the flow consumption 0 L/min when a workpiece is seated.
The result is a great reduction in air consumption compared with the existing model.
* Conditions: Unseated for 5 seconds and seated for 20 seconds (For the G type)

## *Effects of Energy Saving*

### Energy-saving Model

·Air consumption
When placed: 0 L/min (ANR)
When not placed: 10 L/min (ANR)
·Air consumption per cycle:
0.83 L/cycle (ANR)
·Annual operating cycles: 860000

Air consumption (When placed):
**0 L/min (ANR)**

**717 m³/year** (ANR)
$CO_2$ emissions: **42** kg/year
**63** kg reduction in annual $CO_2$ emissions

(**$10**/year)
**($15/year reduction)**

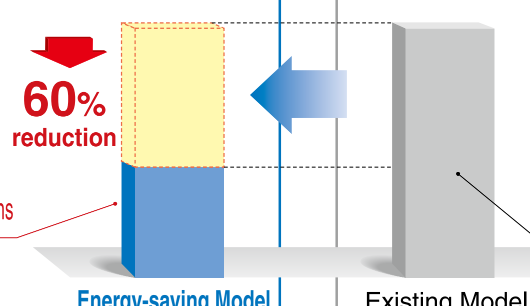
### Existing Model

·Air consumption
When placed: 4 L/min (ANR)
When not placed: 10 L/min (ANR)
·Air consumption per cycle:
208 L/cycle (ANR)
·Annual operating cycles: 860000

Air consumption (When placed):
**4 L/min (ANR)**

**1789 m³/year** (ANR)
$CO_2$ emissions: **105** kg/year

(**$25**/year)




Corresponding value: Air unit \$0.014/m³ (ANR), Air – $CO_2$ conversion factor 0.0586 kg/m³ (ANR)

# Intermittent Blow Circuit *IZE110-X238*

**CO2 emissions (Air consumption)**

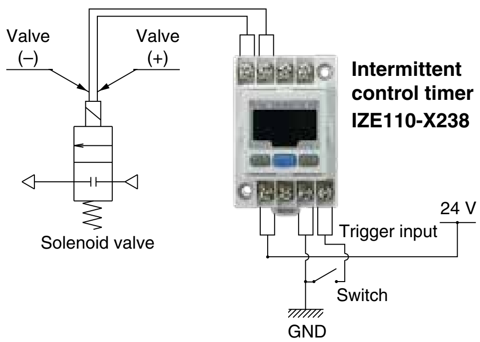
**50% reduction**

## By using intermittent blow based on an intermittent control timer, air consumption can be reduced by 50%.

### Energy-saving Circuit

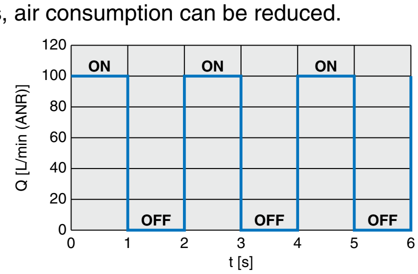
**Intermittent Blow Circuit**

**[Output under timer control]**



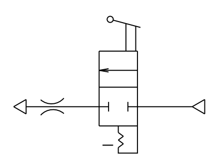

The duty ratio can be freely adjusted.
By setting the duty ratio to one that has the same blow effectiveness, air consumption can be reduced.

Example:

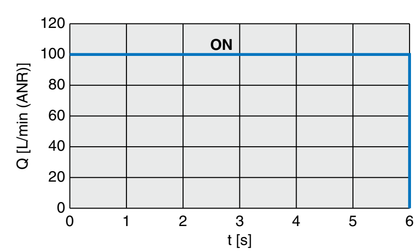



### Existing Circuit

**Continuous Blow Circuit**



The duty ratio is equivalent to 100%.




## Effects of Energy Saving

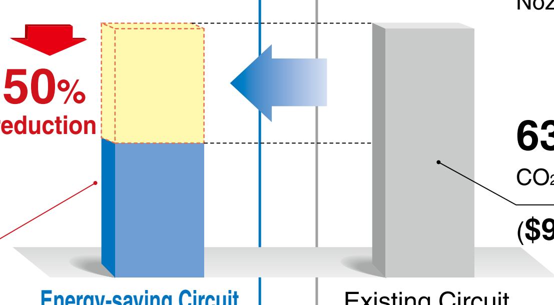
### Energy-saving Circuit

Pressure right before: 0.2 MPa
Blow time: 10 s
(Frequency: 12 times/h)
One blow operation:
ON for 1 s, OFF for 1 s;
Repeated a total of 5 times
Working hours: 10 h/day
(250 days/year)
Nozzle diameter: 1 mm

**318.2 m³/year (ANR)**
CO2 emissions: **19** kg/year
**19** kg reduction in annual CO2 emissions

($**5**/year)
**($5/year reduction)**

**50% reduction**




### Existing Circuit

Pressure right before: 0.2 MPa
Blow time: 10 s
(Frequency: 12 times/h)
Working hours:
10 h/day (250 days/year)
Nozzle diameter: 1 mm

**636.3 m³/year (ANR)**
CO2 emissions: **38** kg/year

($**9**/year)

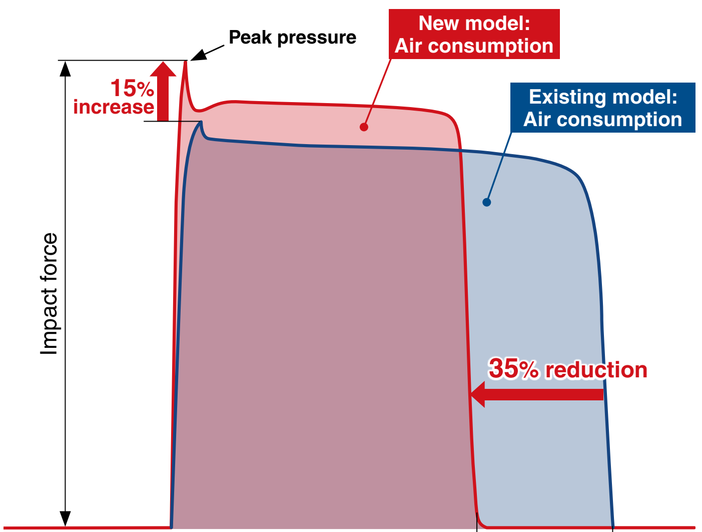
Corresponding value: Air unit \$0.014/m³ (ANR), Air – CO2 conversion factor 0.0586 kg/m³ (ANR)

# Pulse Valve **Valve for Dust Collector**
## *JSXFA Series*

**Peak pressure**
**15%*1 increase**

**$CO_2$ emissions (Air consumption)**
**35%*1 reduction**

## High peak pressure and low air consumption

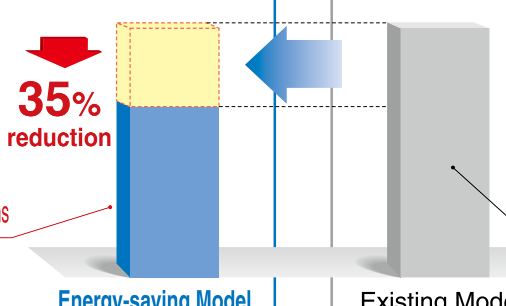



OFF response time: 45% reduction

*1 When the pilot valve mounted on the JSXFA-06 is energized (ON time) for 100 ms

### Effects of Energy Saving

| Energy-saving Model | Existing Model |
|---|---|
| ·Optimized internal geometry<br>·Improved response | ·Flow path construction with a large pressure loss<br>·Long response time |
| Injection quantity per cycle: **57 L/cycle (ANR)** | Injection quantity per cycle: **88 L/cycle (ANR)** |
| Pressure: 0.9 MPa<br>Energizing time: 100 ms<br>Annual operating cycles: 240000 | Pressure: 0.9 MPa<br>Energizing time: 100 ms<br>Annual operating cycles: 240000 |
| **13680** $m^3$/year (ANR)<br>$CO_2$ emissions: **802** kg/year<br>**436** kg reduction in annual $CO_2$ emissions | **21120** $m^3$/year (ANR)<br>$CO_2$ emissions: **1238** kg/year |
| (**$192**/year)<br>**($104/year reduction)** | (**$296**/year) |

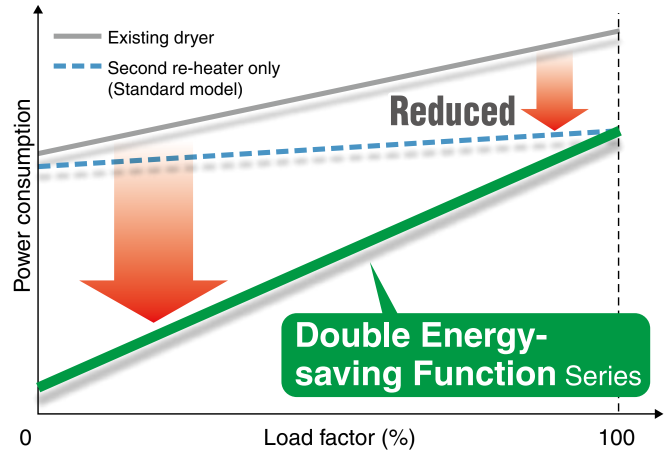



Corresponding value: Air unit $0.014/$m^3$ (ANR), Air – $CO_2$ conversion factor 0.0586 kg/$m^3$ (ANR)

# Refrigerated Air Dryer *IDF□FS Series*

## Double Energy-saving Function Series

Second re-heater | Digital scroll compressor | Stainless steel heat exchanger | Ozone depletion potential ZERO refrigerant




**CO2 emissions**
**(Power consumption)**
**76% reduction**

### The addition of a second re-heater + digital scroll results in high energy savings.

## Energy-saving design

**Up to a 76% reduction (1 kW)*1**

*1 Operating conditions: The IDF125FS in energy-saving operation mode
- Ambient temperature 32°C ● Inlet air temperature 40°C
- Inlet air pressure 0.7 MPa ● Air flow rate = Rated flow x 0.4
- Power supply frequency 60 Hz ● Power supply voltage 200 V ● Set dew point = 30°C

## Example 1 year (Spring to Winter) power consumption

Reduced

Compared with the standard model (constant compressor operation), the **Double Energy-saving Function Series** can reduce power consumption by 43%!*1 per year

*1 The IDF125FS was used for this example.


* **[Trial calculation conditions]** Days of operation per year = 240 days (60 days each in spring, summer, autumn, and winter), Operating hours per day = 12 hours
For details about the dryer operating conditions for each season, refer to the **Web Catalog** (IDF□FS series.).

Corresponding value: Power consumption – $CO_2$ conversion factor 0.587 kg - $CO_2$/kWh

# 7 Energy-saving circuit



**UNIT CONVERSIONS**

| | unit | conversion | result |
|---|---|---|---|
| length | m | x 3.28 | ft |
| | mm | x 0.04 | in |
| mass | g | x 0.04 | oz |
| volume | $cm^3$ | ÷ 16.387 | $in^3$ |
| | L | x 61.024 | $in^3$ |
| speed | mm/s | ÷ 25.4 | in/s |
| pressure | MPa | x 145 | psi |
| | kPa | ÷ 6.895 | psi |
| temperature | °C | x1.8 then add 32 | °F |
| torque | N·m | x 0.738 | ft-lb |
| force | N | ÷ 4.448 | lbf |
| flow | L/min | ÷ 28.317 | cfm |
| | JPY | x 0.0094 | dollar |

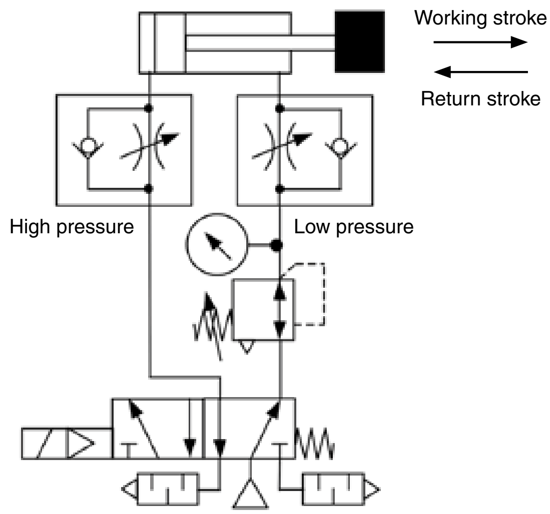
# Two-pressure drive circuit

**CO2 emissions (Air consumption)**

**24% reduction**

## Low pressure is supplied during the non-working return stroke.

In general usage, a cylinder is used to clamp, press fit, or transfer workpieces during the working stroke, with no work taking place during the return stroke. Therefore, it is sufficient to only supply low pressure during the return stroke. In this way, by using a two-pressure drive circuit as the driving circuit, it is possible to reduce the amount of compressed air used to supply pressure on the return side.



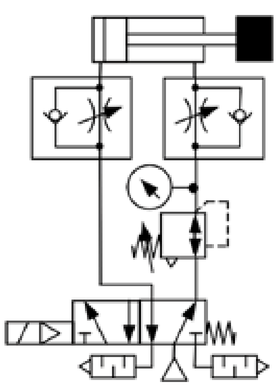

### Two-pressure Drive Circuit

By installing a regulator with backflow function in the piping between the rod side cylinder port and the solenoid valve port, it is possible to set the set pressure to low pressure, resulting in a reduction in the amount of compressed air consumed on the return stroke. For the two-pressure drive circuit, sudden extension may occur at the beginning of the working stroke, which may result in a delayed start of the return stroke. In order to resolve this phenomenon, we recommend incorporating an SMC air-saving speed controller.

**Effects of Energy Saving**

### Energy-saving Circuit

Cylinder
I.O.: ø100
Rod size: ø30
Stroke: 400 mm
Piping I.O.: 8 mm
Length: 4 m
Rod side supply pressure: 0.5 MPa
Head side supply pressure: 0.2 MPa
Operating frequency: 5 cycles/min
Operating hours: 2000 hours/year



Air consumption
**28.8 L (ANR)/cycle**

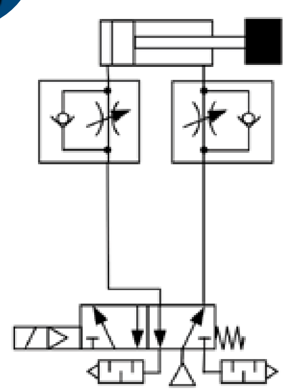
Air consumption
**17280** $m^3$/year (ANR)
$CO_2$ emissions: **1013** kg/year
**323** kg reduction in annual $CO_2$ emissions

**24% reduction**

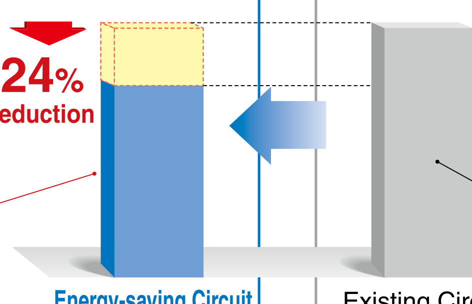
Cost of compressed air
(**$241**/year)
**($77/year reduction)**

### Existing Circuit

Cylinder
I.O.: ø100
Rod size: ø30
Stroke: 400 mm
Piping I.O.: 8 mm
Length: 4 m
Supply pressure: 0.5 MPa
Operating frequency: 5 cycles/min
Operating hours: 2000 hours/year



Air consumption
**38 L (ANR)/cycle**




Air consumption
**22800** $m^3$/year (ANR)
$CO_2$ emissions: **1336** kg/year

Cost of compressed air
(**$319**/year)

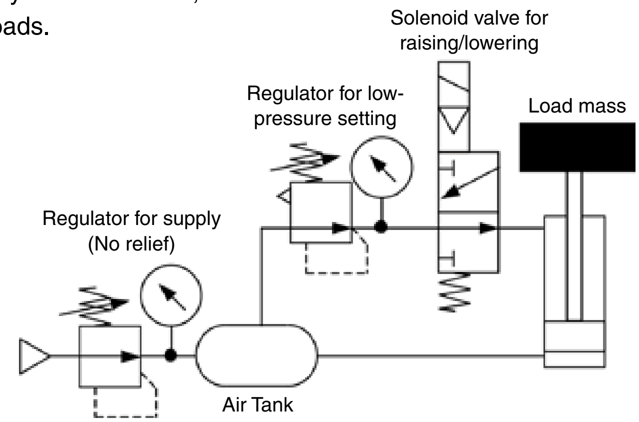
Corresponding value: Air unit $0.014/$m^3$ (ANR), Air – $CO_2$ conversion factor 0.0586 kg/$m^3$ (ANR)

# Energy-saving lifter circuit

**CO2 emissions (Air consumption)**
**71% reduction**

## By using an air tank, a substantial reduction in air consumption is possible.

An air tank can be used to substantially reduce the amount of air consumed by the lifter circuit, which is used to raise and lower loads.

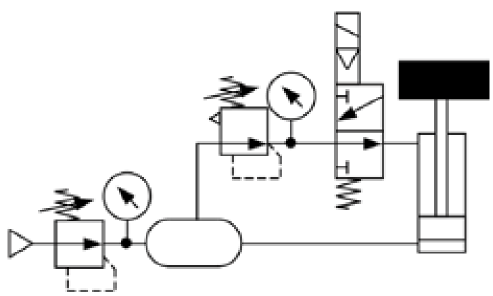



### Energy-saving Lifter Circuit

When the cylinder rises, the compressed air in the upper cylinder chamber is exhausted, and the compressed air accumulated in the air tank is supplied to the lower cylinder chamber. Then, when the cylinder lowers, low-pressure compressed air is supplied to the upper cylinder chamber, and the compressed air from the lower cylinder chamber is accumulated in the air tank. The only compressed air consumed during a cycle operation is the low-pressure compressed air supplied to the upper cylinder chamber. Compared with a regular circuit, air consumption can be reduced by 70 to 80%.

**Effects of Energy Saving**

### Energy-saving Circuit



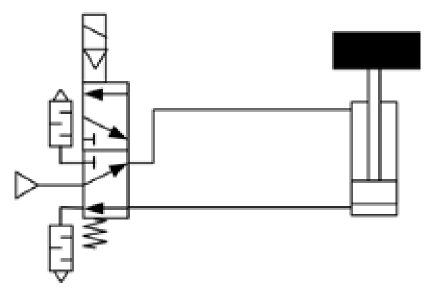
Cylinder
I.O.: ø180
Rod size: ø45
Stroke: 500 mm
Tank capacity: 100 L
Head pressure: 0.36 to 0.42 MPa
Rod side supply pressure: 0.2 MPa
Operating frequency: 1 cycle/min
Operating hours: 2000 hours/year

Air consumption
**35.8 L (ANR)/cycle**

Air consumption
**4286 m³/year (ANR)**
$CO_2$ emissions: **251** kg/year
**614** kg reduction in annual $CO_2$ emissions

Cost of compressed air
(**$60**/year)
**$146/year reduction)**

### Existing Circuit

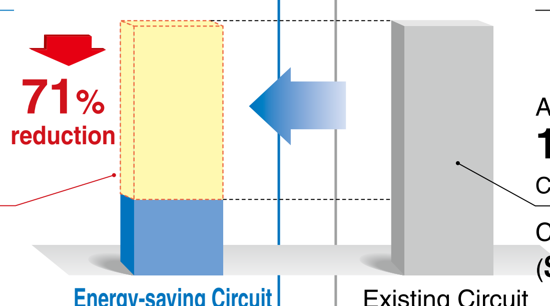


Cylinder
I.O.: ø180
Rod size: ø45
Stroke: 500 mm
Supply pressure: 0.5 MPa
Operating frequency: 1 cycle/min
Operating hours: 2000 hours/year

Air consumption
**123 L (ANR)/cycle**

Air consumption
**14760 m³/year (ANR)**
$CO_2$ emissions: **865** kg/year

Cost of compressed air
(**$206**/year)




Corresponding value: Air unit $0.014/m³ (ANR), Air – $CO_2$ conversion factor 0.0586 kg/m³ (ANR)

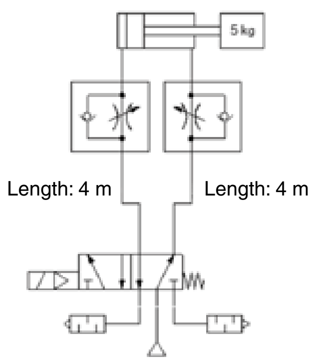
# Optimized cylinder driving system

**$CO_2$ emissions**
**(Air consumption)**
**42% reduction**

## Our model selection software can be used to find the smallest possible model which meets your requirements, helping you reduce your air consumption.

Example

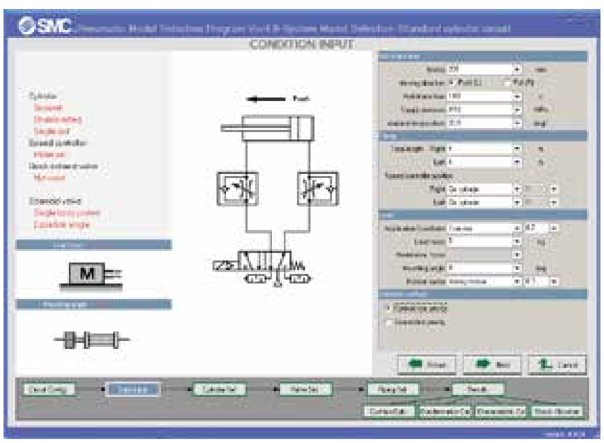
Stroke: 200 mm
Stroke time: 1 second



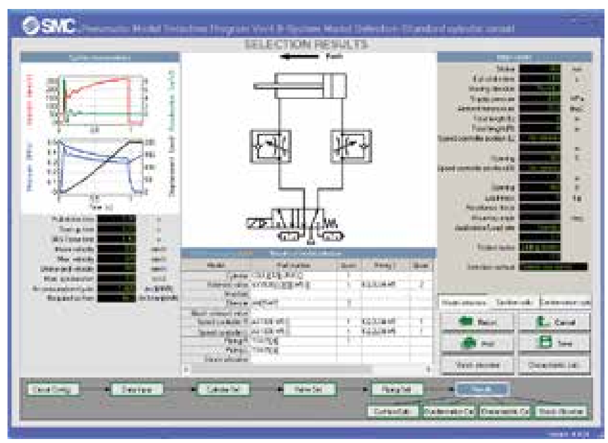

Selection of the optimal size via the selection software

1. Input operating conditions.
2. Conduct a simulation.
3. The optimal size model will be displayed.

**Operating condition input screen**



**Results screen**



**Effects of Energy Saving**

## Energy-saving Circuit

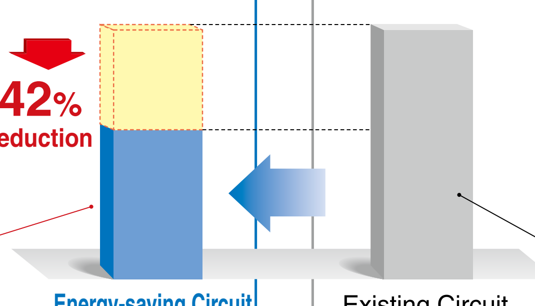
Bore size: ø32 CQ2□32-200
Piping I.O.: ø4 T0425

Air consumption
**1.885 L (ANR)/cycle**

When it is operated 900000 times/year
**1696.5** $m^3$/year (ANR)
$CO_2$ emissions: **100** kg/year
**73** kg reduction
in annual $CO_2$ emissions

(**$24**/year)
**($18/year reduction)**

**42% reduction**




## Existing Circuit

Bore size: ø40 CQ2□40-200
Piping I.O.: ø6 T0604

Air consumption
**3.277 L (ANR)/cycle**

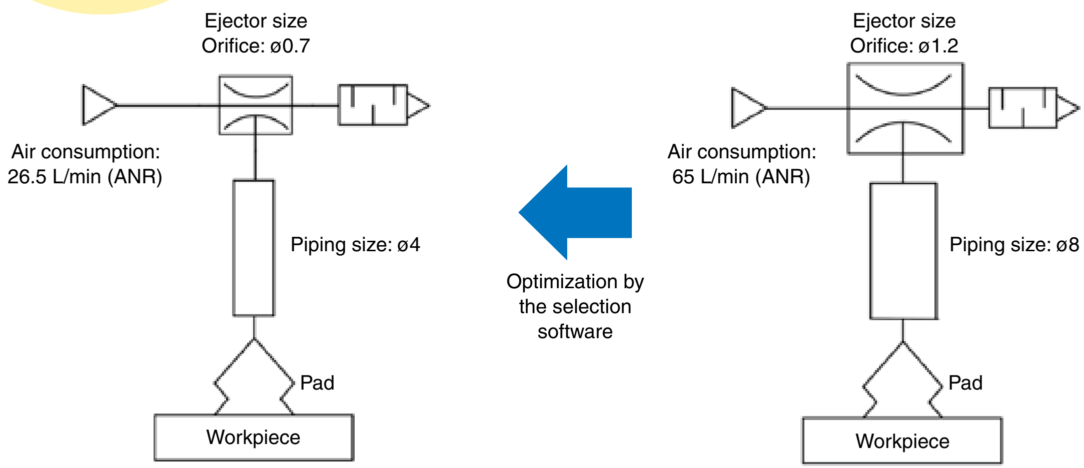
When it is operated 900000 times/year
**2,949** $m^3$/year (ANR)
$CO_2$ emissions: **173** kg/year
(**$41**/year)

Corresponding value: Air unit $0.014/$m^3$ (ANR), Air – $CO_2$ conversion factor 0.0586 kg/$m^3$ (ANR)

# Optimized vacuum adsorption transfer system

**$CO_2$ emissions (Air consumption)**
**59% reduction**

**By using our model selection software to find an optimal size model which meets your requirements, you can reduce your air consumption.**




By selecting optimal size piping, a smaller ejector can also be used, resulting in reduced air consumption.

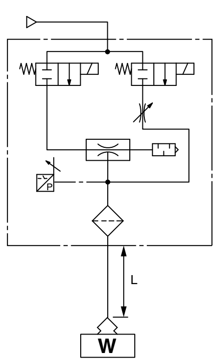
The larger the piping is, the larger the ejector must be, and the greater the amount of air that is consumed.

## Effects of Energy Saving

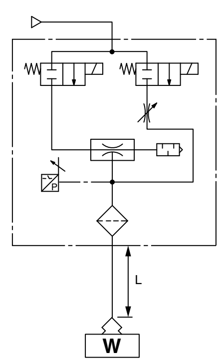
### Energy-saving Circuit

Ejector: ZK2A07K-06
(Orifice: ø0.7)
Tubing: TU0425
Pad: ZP2-TB30MTN-H5

Suction time: 0.042 seconds
Safety factor: 4.2
Air consumption: 26.5 L/min (ANR)
Operating frequency: 10 times/h
Operating time: 5 s/time
Operating hours: 2000 hours/year
Number of circuits: 30




### Existing Circuit



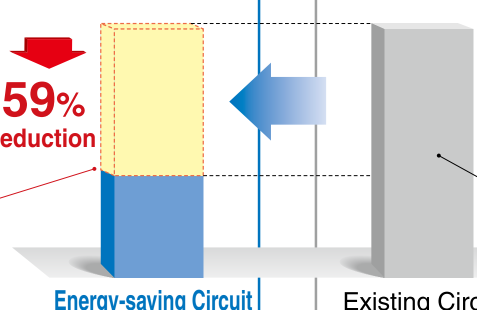

Ejector: ZK2A12K-06
(Orifice: ø1.2)
Tubing: TU0805
Pad: ZP2-TB30MTN-H5

Suction time: 0.079 seconds
Safety factor: 4.3
Air consumption: 65 L/min (ANR)
Operating frequency: 10 times/h
Operating time: 5 s/time
Operating hours: 2000 hours/year
Number of circuits: 30

$CO_2$ emissions: **78** kg/year
**113** kg reduction
in annual $CO_2$ emissions

Cost of compressed air
(**$19**/year)
**($27/year reduction)**

**59% reduction**




$CO_2$ emissions: **191** kg/year

Cost of compressed air
(**$45**/year)

Corresponding value: Air unit \$0.014/m³ (ANR), Air – $CO_2$ conversion factor 0.0586 kg/m³ (ANR)

# 8 Compact and lightweight products

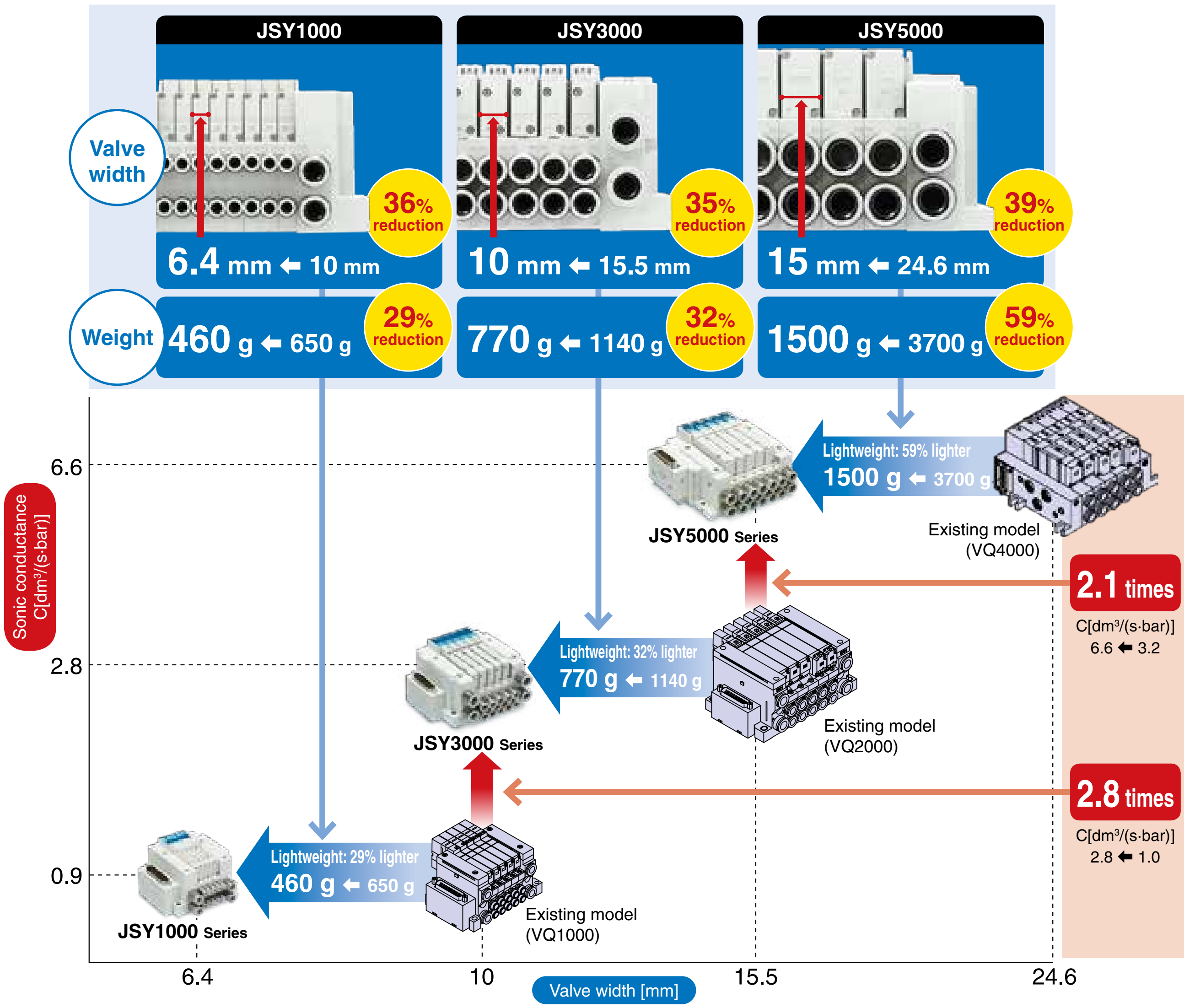
# 8 Compact and lightweight products

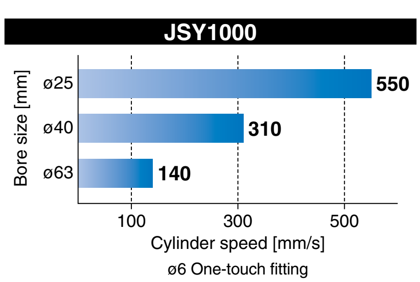
# Plug-in Type Compact 5-Port Solenoid Valve *JSY* Series

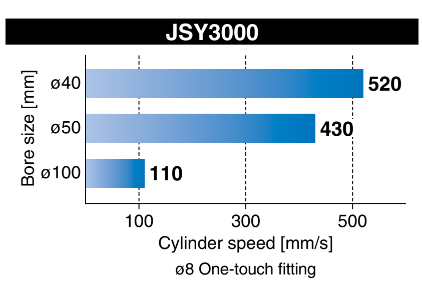
**Weight**
Max. 59%*1 reduction
3700 g ➡ 1500 g

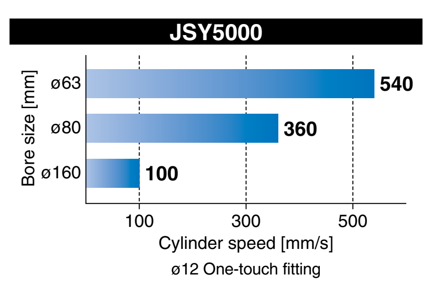
**Valve width**
Max. 39%*1 reduction
24.6 mm ➡ 15 mm

*1 Compared with the existing VQ4000 series



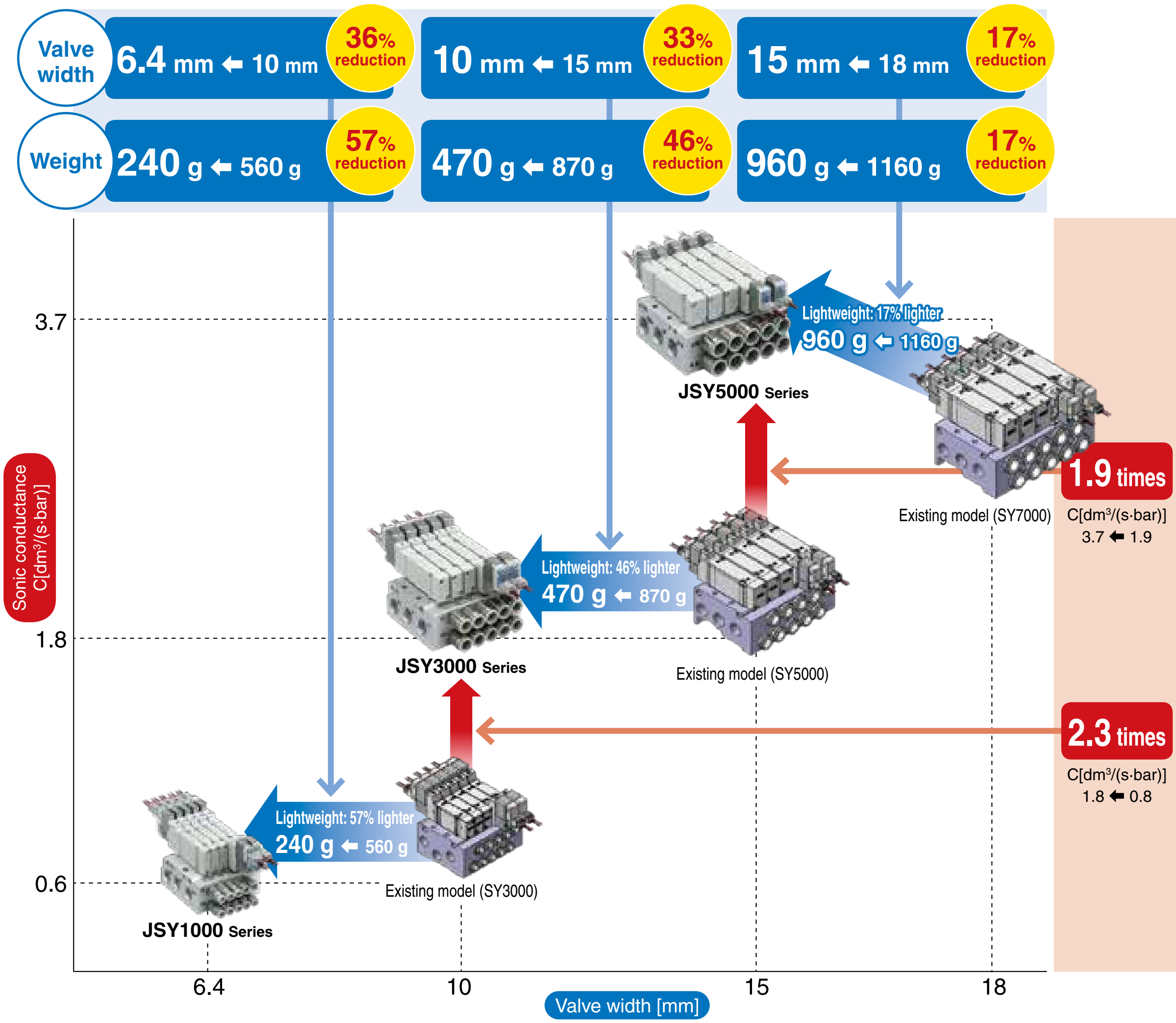



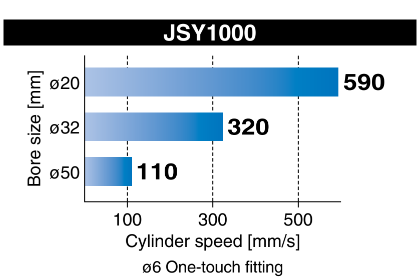
# Non Plug-in Type Compact 5-Port Solenoid Valve *JSY Series*

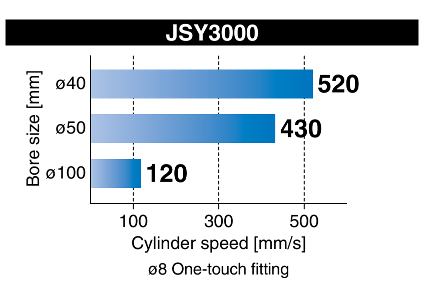
**Weight**
Max. 57%*1 reduction
560 g ➡ 240 g

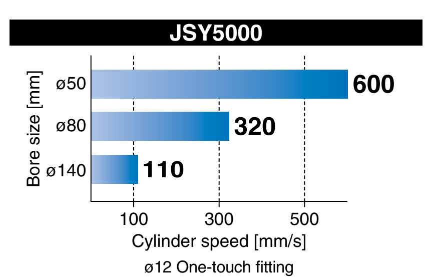
**Valve width**
Max. 36%*1 reduction
10 mm ➡ 6.4 mm

*1 Compared with the existing SY3000 series



# Air Cylinder *JCM* Series
## ø20, ø25, ø32, ø40

**Weight**

Max. **54%**[*1] reduction

0.69 kg ➡ **0.32 kg**

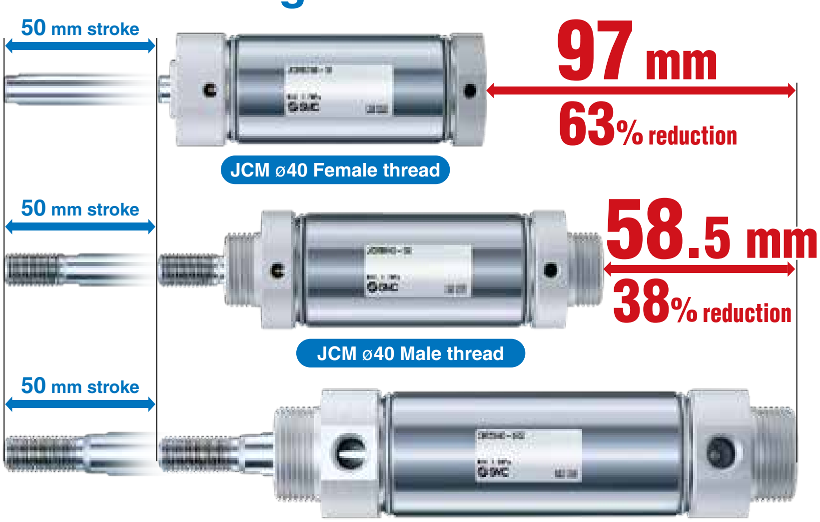
**Overall length**

Approx. **1/3**[*1]

154 mm ➡ **57 mm**

*1 Compared with the existing CM2B series, ø40, 50 mm stroke

## Overall length shortened



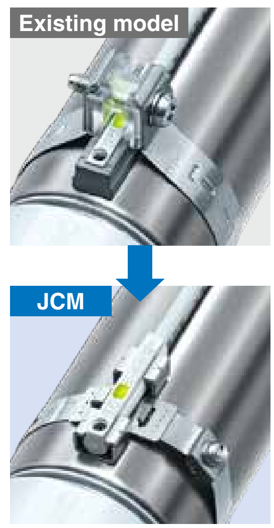

Existing model ø40 (CM2 series)

## Shortened height

**New mounting band for auto switch**

**Mounting height**

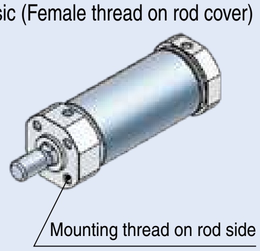
**Approx. 8 mm shorter**



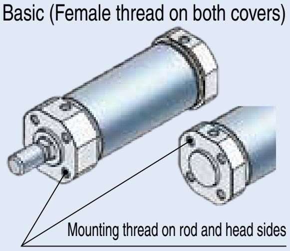

## Various cover types available

**Direct mounting is possible.**

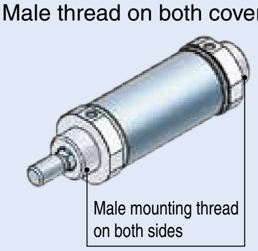
Basic (Female thread on rod cover)



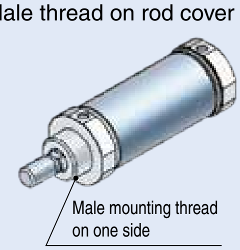

Basic (Female thread on both covers)




Male thread on both covers

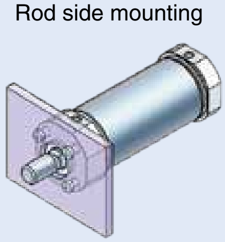



Male thread on rod cover

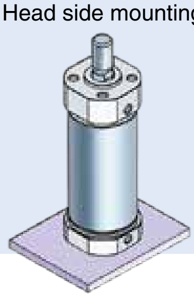



**Examples**

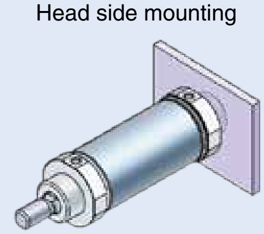
Rod side mounting



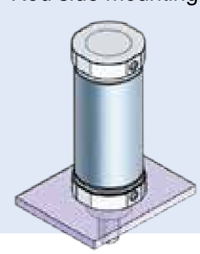
Head side mounting



Head side mounting



Rod side mounting



# Air Cylinder *JMB* Series
## ø32, ø40, ø45, ø50, ø56, ø63, ø67, ø80, ø85, ø100

**Weight**
**Max. 36%*1 reduction**
1.56 kg ➡ 1.00 kg

**Overall length**
**Max. 11%*1 reduction**
256 mm ➡ 229 mm

*1 Compared with the existing MB series, ø50, 100 mm stroke

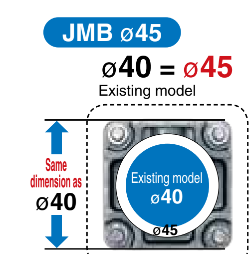
## Overall length shortened


## Intermediary bore sizes ◎Air saving ◎Space saving

ø40*1 — **ø45** — ø50*1 — **ø56** — ø63*1 — **ø67** — ø80*1 — **ø85** — ø100*1

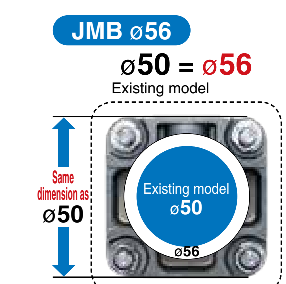
*1 Existing model

ø40 / ø45: Same external dimensions
ø50 / ø56: Same external dimensions
ø63 / ø67: Same external dimensions
ø80 / ø85: Same external dimensions



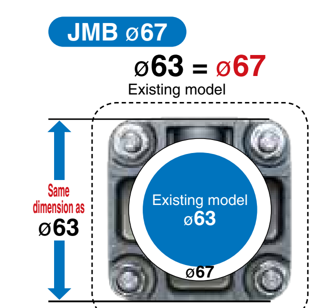

Existing model ø50

Theoretical output ø45/ø40 = 1.27 times



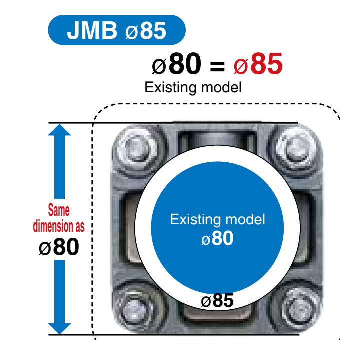

Existing model ø63

Theoretical output ø56/ø50 = 1.25 times




Existing model ø80

Theoretical output ø67/ø63 = 1.13 times




Existing model ø100

Theoretical output ø85/ø80 = 1.13 times

# Air Cylinder *CS2 Series*
## ø125, ø140, ø160

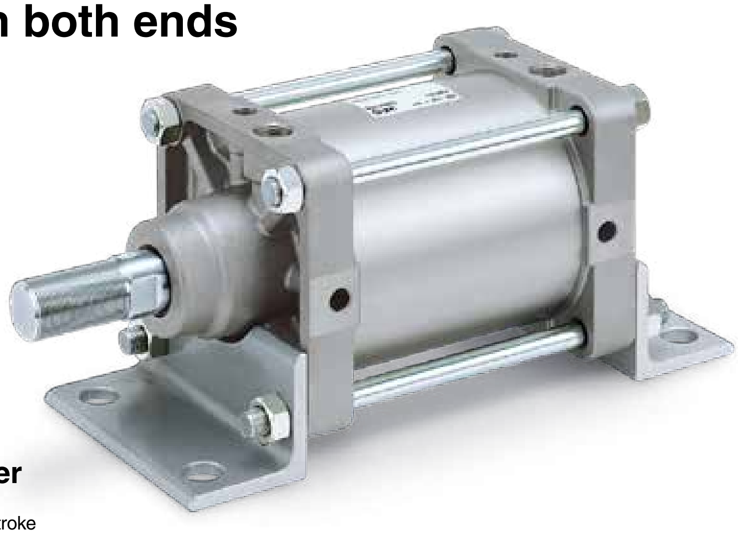
**Weight**

**62% reduction**

21.4 kg ➡ **8.2 kg**

Compared with a ø140, 100 mm stroke CS1 (steel tube) series model

## More lightweight due to the aluminum covers on both ends



### Weight reduced by a change in the cover material

∗ Compared at a 100 mm stroke

| Bore size [mm] | **CS2** (Aluminum tube) [kg] | CS1 (Steel tube) [kg] | Reduction rate [%] |
|---|---|---|---|
| 125 | **7.0** | 17.9 | 61 |
| 140 | **8.2** | 21.4 | 62 |
| 160 | **11.3** | 28.8 | 61 |

# Mini Free Mount Cylinder *CUJ Series*
## ø4, ø6, ø8, ø10, ø12, ø16, ø20

## Miniature body

**Overall length**
**Max. 20%*1 reduction**
29.5 mm ➡ 23.5 mm

**Volume**
**Max. 45%*1 reduction**
382 cm³ ➡ 211 cm³

*1 Compared with the CQS series cylinders, ø20

**Overall length**
**Max. 64%*2 reduction**
36 mm ➡ 13 mm

**Volume**
**Max. 70%*2 reduction**
129 cm³ ➡ 38.6 cm³

*2 Compared with the CU series cylinders, ø10

**Dimensions (With Magnet)** [mm]

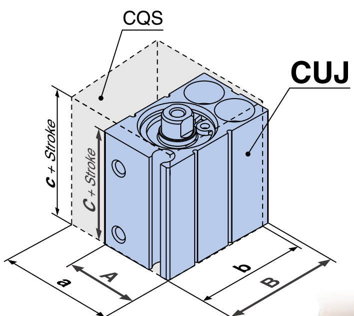
| Bore size | A(a) | B(b) | C(c) |
|---|---|---|---|
| 12 | 17(25) | 26.5(25) | 19.5(22) |
| 16 | 21(29) | 29.5(29) | 21(22) |
| 20 | 25(36) | 36(36) | 23.5(29.5) |

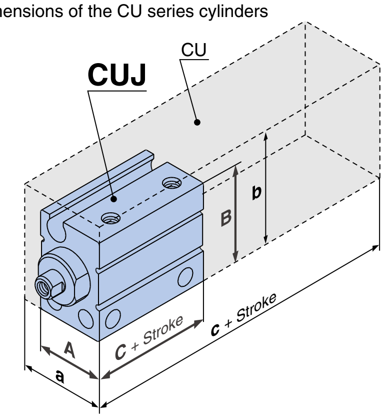
( ): Dimensions of the CQS series cylinders

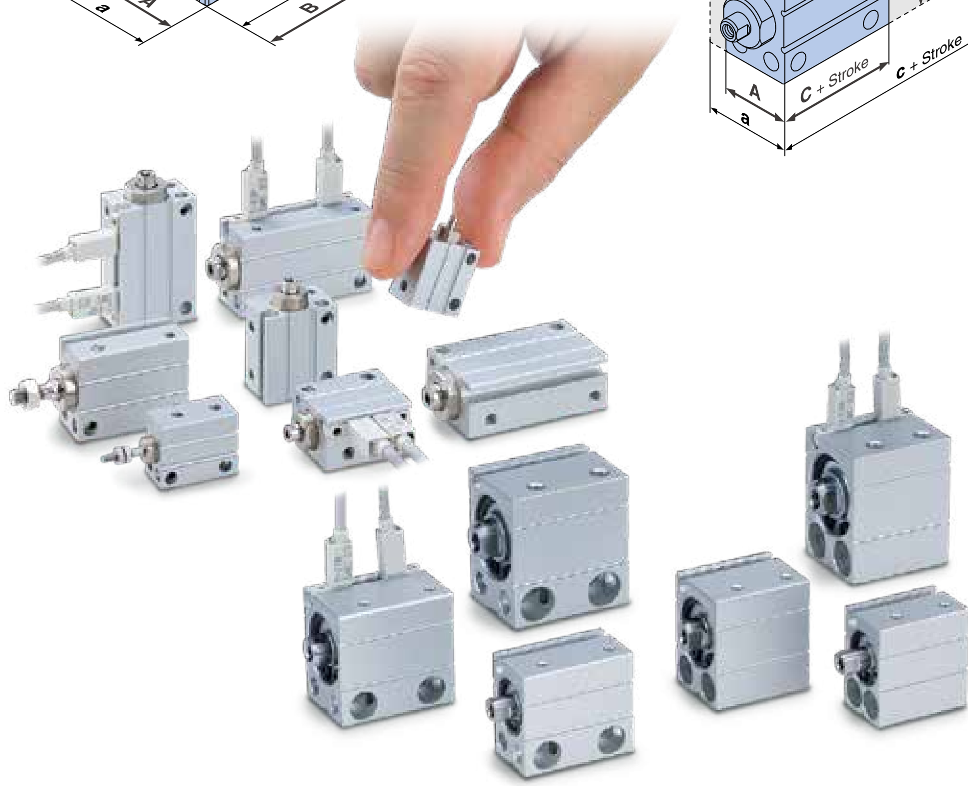
**Dimensions (Without Magnet)** [mm]

| Bore size | A(a) | B(b) | C(c) |
|---|---|---|---|
| 4 | 10(—) | 15(—) | 13(—) |
| 6 | 13(13) | 19(22) | 13(33) |
| 8 | 13(—) | 21(—) | 13(—) |
| 10 | 13.5(15) | 22(24) | 13(36) |
| 12 | 17(—) | 26.5(—) | 15.5(—) |
| 16 | 21(20) | 29.5(32) | 16.5(30) |
| 20 | 25(26) | 36(40) | 19.5(36) |

( ): Dimensions of the CU series cylinders



# Compact Air Cylinder *JCQ Series*

## ø12, ø16, ø20, ø25, ø32, ø40, ø50, ø63, ø80, ø100

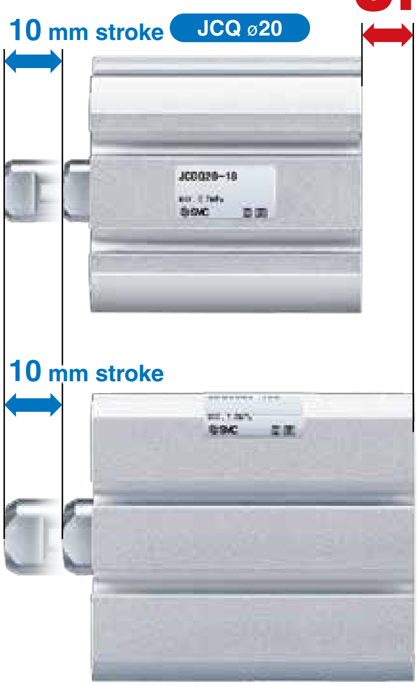
**Weight**
Max. **45**%*1 reduction
150 g ➡ **82 g**

**Volume**
Max. **37**%*1 reduction
76 cm³ ➡ **48 cm³**

*1 Compared with the existing CDQS series, ø25, 10 mm stroke

## Overall length shortened

**6.5 mm**



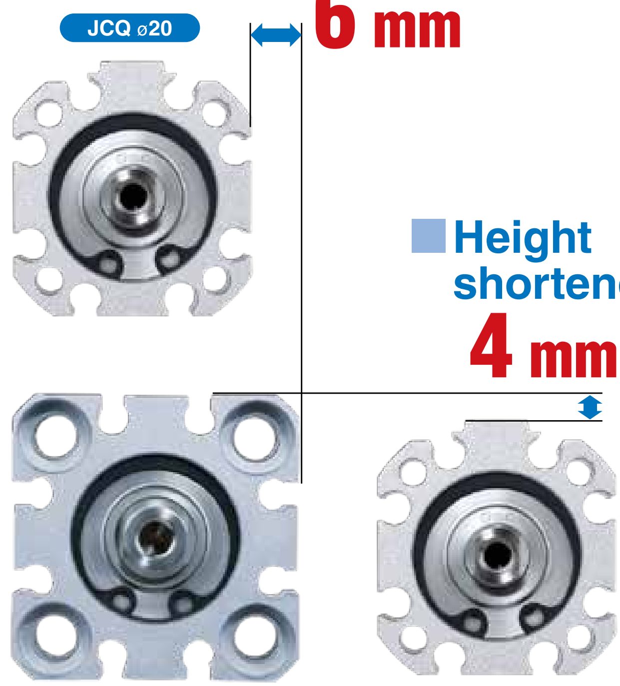

Existing model ø20
(CDQS series)

## Width shortened

**6 mm**

## Height shortened

**4 mm**

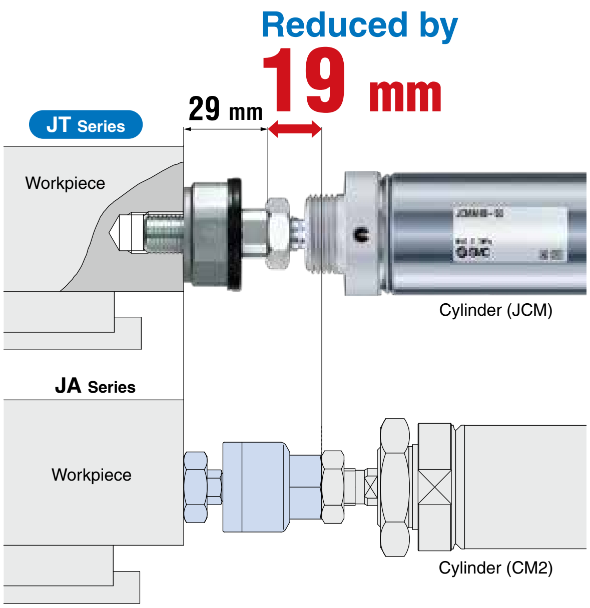



Existing model ø20
(CDQS series)

# Floating Joint *JT* Series
20, 32, 40

**Weight**
**Max. 56% reduction**
50 g ➡ 22 g

Compared with the existing JA20

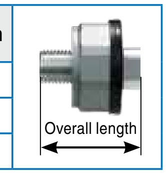



**Weight Comparison**

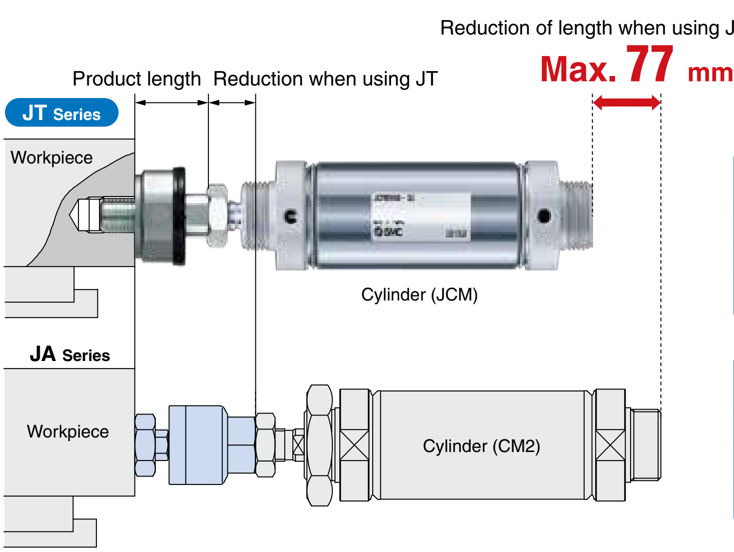
| Model | JA Series | | JT Series | Reduction rate |
|---|---|---|---|---|
| JT20 | 50 g | ➡ | 22 g | 56% |
| JT32 | 70 g | ➡ | 38 g | 46% |
| JT40 | 160 g | ➡ | 98 g | 39% |

**Overall Length Comparison**

| Model | Connection thread | Shortened dimensions | Overall length |
|---|---|---|---|
| JT20 | M8 x 1.25 | 12.3 mm | 27.2 mm |
| JT32 | M10 x 1.25 | 13.0 mm | 33.0 mm |
| JT40 | M14 x 1.5 | 19 mm | 43.0 mm |




## More compact and lightweight combination are available by using the JT series with a JCM series cylinder.




**Overall Length Comparison**

| Model | JA + CM2 Series | | JT + JCM Series | Reduction rate |
|---|---|---|---|---|
| JT20 | 139.5 mm | ➡ | 90.2 mm | 35% |
| JT32 | 149.0 mm | ➡ | 96.0 mm | 36% |
| JT40 | 189.0 mm | ➡ | 112.0 mm | 41% |

**Weight Comparison**

| Model | JA + CM2 Series | | JT + JCM Series | Reduction rate |
|---|---|---|---|---|
| JT20 | 190 g | ➡ | 102 g | 46% |
| JT32 | 350 g | ➡ | 188 g | 46% |
| JT40 | 720 g | ➡ | 378 g | 48% |

# Compact Slide *MXH* Series

## ø6, ø10, ø16, ø20

**Weight**

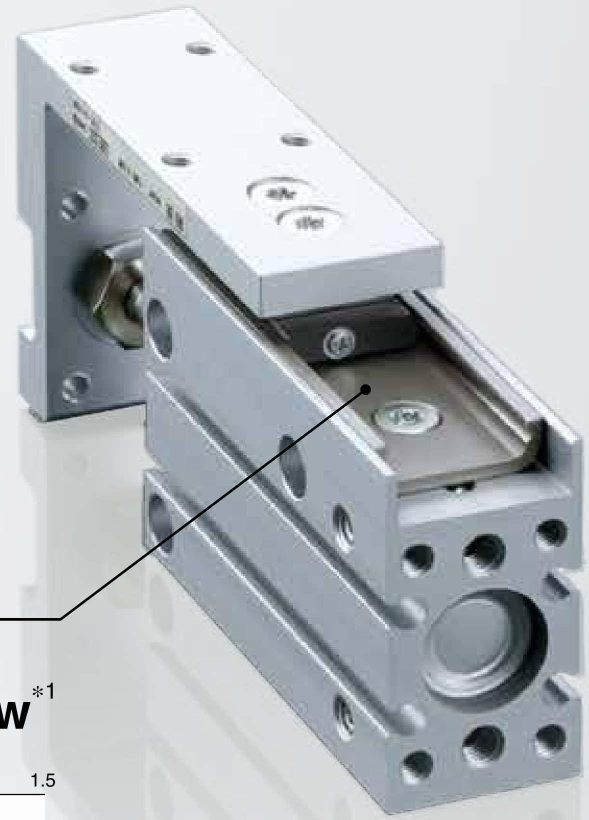
**Max. 19% reduction**

455 g ➡ 369 g

(Existing MXH series, ø20-10 mm stroke)

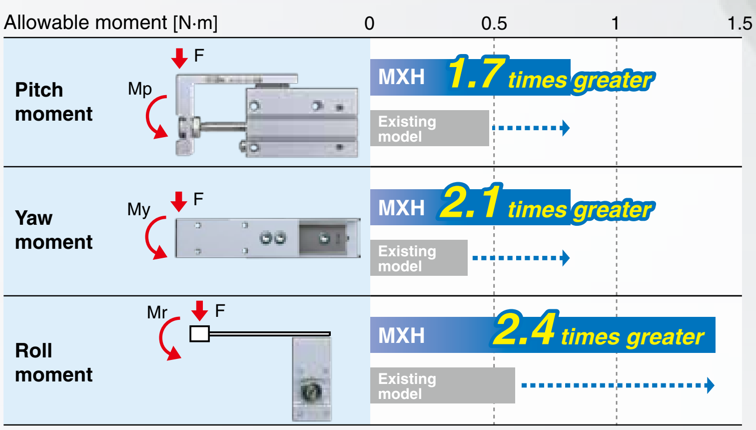
**Allowable moment**

**Improved by up to 240%**

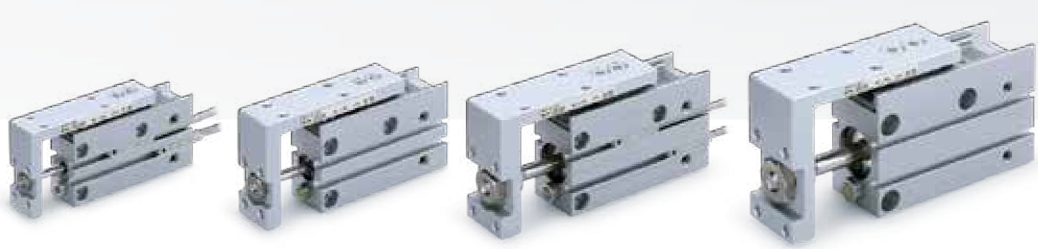


# With new high rigidity linear guide

## Allowable moment improvement illustrated below*1




*1 Allowable moment caused by static load
(The above graph is a comparison between the new MXH and the existing MXH6.)



# Air Slide Table *MXQ* Series
## ø6, ø8, ø12, ø16, ø20, ø25

## Reduced in height and weight with thinner table

**Height**
Max. 10%*1 reduction
30 mm ➡ 27 mm

**Weight**
Max. 22%*1 reduction
380 g ➡ 298 g

**Allowable kinetic energy**
Max. 64%*1 increase
0.055 J ➡ 0.09 J

*1 Compared between the double-ported type and the existing MXQ12-30


**Double-ported type MXQ□A**

■Height reduced by 10% of the existing model
30 mm → 27 mm
■Weight reduced by 22%
380 g → 298 g
For MXQ12A-30ZN
Improved visibility
Pilot port
For ø16
Two auto switch mounting grooves
■A piping port and auto switch mounting groove are provided on both sides.

**Low thrust with high rigidity type MXQ□B**

Guide rigidity according to thrust improved
■Guide rigidity improved by 50%
(For MXQ8B and MXQ8A)
■Cylinder can be downsized when load is light!
・Reduced in height
・Reduced in air consumption
・Lightweight

**Single side-ported type MXQ□C**

■Compact body with good switch visibility
Applicable to ø8 and ø12 only
■Compact design, Two auto switch mounting grooves on one side

**Height interchangeable type MXQ□**

■Same height as the existing model
■Visibility of auto switches improved
■Interchangeable in mounting with the existing model

### Guide Size and Cylinder Bore Size Combination Chart

When the height needs to be the same as the existing model, choose the MXQ□, height interchangeable type.

| Guide size | Max. load mass | MXQ□A Bore size | MXQ□A height | MXQ□B Bore size | MXQ□B height | MXQ□C Bore size | MXQ□C height | MXQ□ Bore size | MXQ□ height |
|---|---|---|---|---|---|---|---|---|---|
| Small guide 32 mm | 0.6 kg | ø6 | 23 mm | — | — | ø6 | Not available Use the MXQ□, height interchangeable type. | ø6 | 20 mm Standard/Symmetric type (Figure shows standard model) |
| 32 mm | 1 kg | ø8 | 23 mm | ø6 | 20 mm Standard/Symmetric type (Figure shows standard model) | ø8 | 21 mm Standard/Symmetric type (Figure shows standard model) | ø8 | 23 mm Standard/Symmetric type (Figure shows standard model) |
| 40 mm | 2 kg | ø12 | 27 mm | ø8 | 23 mm Standard/Symmetric type (Figure shows standard model) | ø12 | 27 mm Standard/Symmetric type (Figure shows standard model) | ø12 | 30 mm Standard/Symmetric type (Figure shows standard model) |
| 50 mm | 4 kg | ø16 | 35 mm | ø12 | 30 mm Standard/Symmetric type (Figure shows standard model) | ø16 | | ø16 | 37 mm |
| 60 mm | 6 kg | ø20 | 43 mm | ø16 | 37 mm | ø20 | Not available Use the MXQ□A, double-ported type. | ø20 | 46 mm |
| Large guide 70 mm | 9 kg | ø25 | 52 mm | ø20 | 46 mm | ø25 | | ø25 | 55 mm |

Purpose of usage ❶ (MXQ□A ø6 → MXQ□B ø6)
Guide rigidity and a large table surface are necessary but thrust is not needed.
Application examples
・Horizontal transfer of workpieces, transfer of tools, low thrust clamping

Purpose of usage ❷ (MXQ□A ø12 → MXQ□B ø8)
A guide with higher rigidity is necessary without changing the thrust from the existing model.
Application examples
・Transfer of workpieces with increased overhang
・High-accuracy and high-thrust clamping

MXQ□A: Size ø16, ø20, and ø25 have two auto switch mounting grooves on both sides.

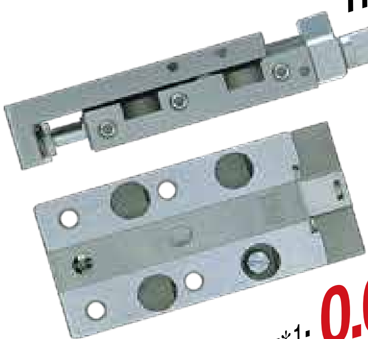
MXQ□B: Size ø16 and ø20 have two auto switch mounting grooves on both sides.

MXQ□: Size ø16, ø20, and ø25 have two auto switch mounting grooves on both sides.

# Air Slide Table *MXJ* Series
## ø4, ø6, ø8, ø12, ø16

## Compact

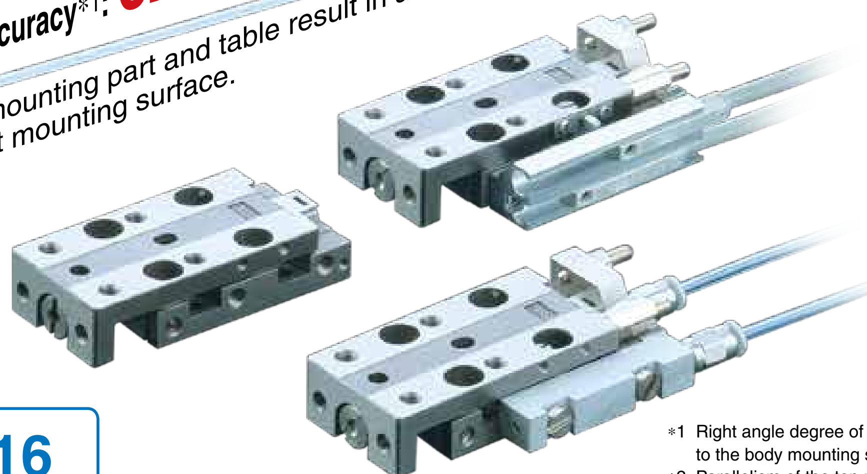
**Height: 10 mm/Width: 20 mm/Length: 43 mm (MXJ4)**



**Traveling parallelism: 0.005 mm**

**Front mounting accuracy*1: 0.01 mm/Top mounting accuracy*2: 0.03 mm**

Integrated front mounting part and table result in a highly accurate and rigid top and front mounting surface.

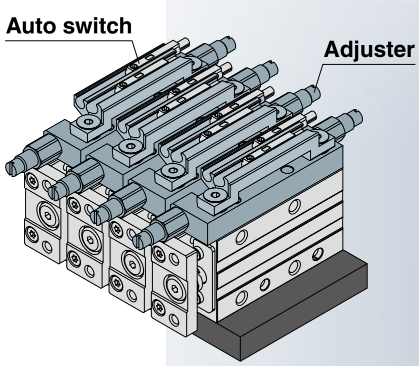


*1 Right angle degree of the front mounting surface to the body mounting surface
*2 Parallelism of the top mounting surface to the body mounting surface

## ø12, ø16

Auto switch and adjuster **can be mounted on the same side.**

**Short pitch mounting is possible.**




# Compact Guide Cylinder *JMGP* Series
## ø12, ø16, ø20, ø25, ø32, ø40, ø50, ø63, ø80, ø100

**Weight**
Max. 69%*1 reduction
0.32 kg ➡ 0.1 kg

**Overall length**
Max. 31%*2 reduction
100 mm ➡ 69.5 mm

**Height**
33%*2 reduction
48 mm ➡ 32 mm

*1 Compared with the existing MGP-Z series, ø16, 10 mm stroke *2 Compared with the existing MGP-Z series, ø32, 25 mm stroke

## Overall length shortened

Existing model ø32

## Height shortened

Existing model ø32

Suitable for pushing, lifting, or clamping in a transport line

# Micro Clamp Cylinder *CKZM16* *-X2800* (Base Type) *-X2900* (Tandem Type)

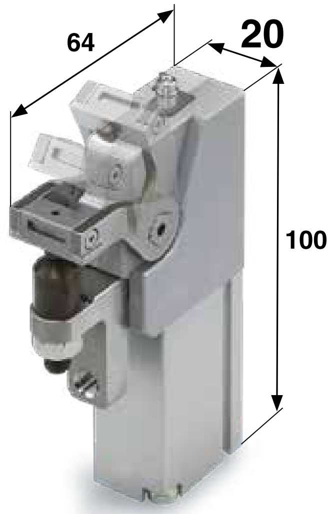
**Compact** | **Lightweight** | **High clamping force** | **High holding force**

**Width**
**20 mm**
Base type,
Tandem type

**Weight**
**250 g**
Base type

## Max. clamping force: 200 N
(Tandem type)
* Operating pressure: 0.6 MPa

## Max. holding force: 300 N
(Base type, Tandem type)
* When operating pressure of 0.2 to 0.6 MPa is applied

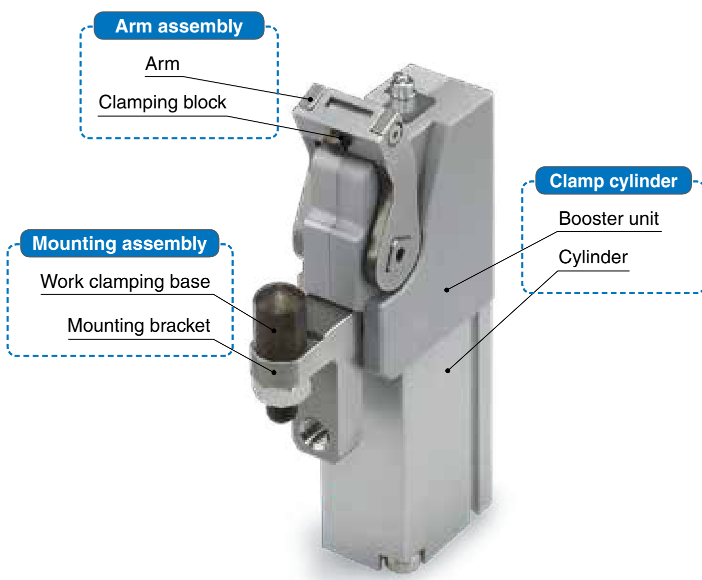



Base type: X2800


Tandem type: X2900

## *Reduction of design assembly labor by unitization*

**Arm assembly** **Mounting assembly**
**added to clamp cylinder**



8 Compact and lightweight products

# Rotary Actuator/Vane Type *CRB Series*

## Size: 10, 15, 20, 30, 40

**Overall length**

**Max. 44%*1 reduction**

100 mm ➡ 55.6 mm

**Weight**

**Max. 48%*2 reduction**

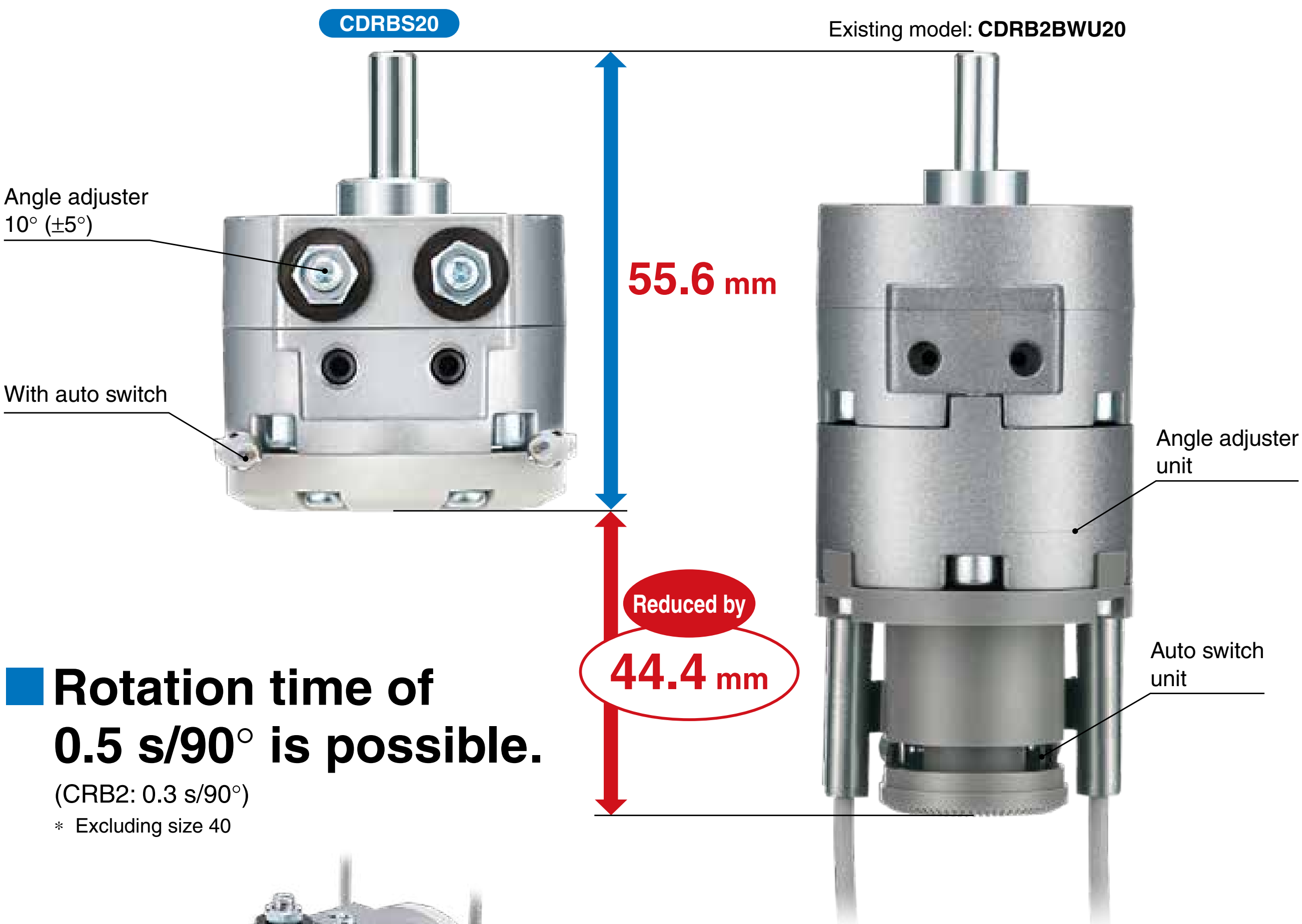
222 g ➡ 115 g

*1 Compared with the existing CDRB2□WU, Size 20

*2 Compared with the existing CDRB2□WU, Size 20, Rotating angle 90°

**Features a compact body with a built-in angle adjuster unit and auto switch unit**

(Size: 20, 30, 40)




## ■ Rotation time of 0.5 s/90° is possible.

(CRB2: 0.3 s/90°)

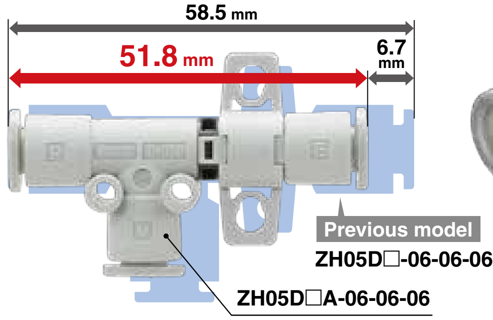
* Excluding size 40

# Body Ported Type Vacuum Ejector *ZH Series*

## Compact and lightweight

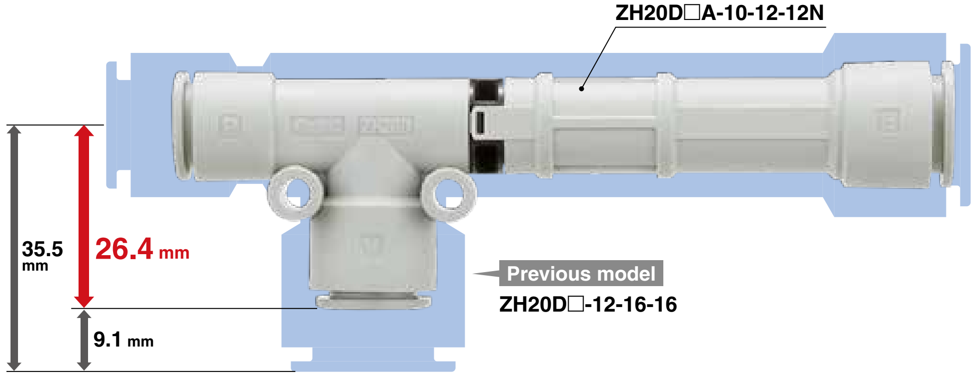
**Overall length**
**Max. 11% reduction**
58.5 mm ➡ 51.8 mm

Compared with the previous ZH05D☐



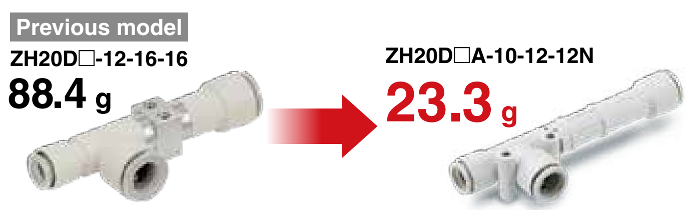

**Port height**
**Max. 25% reduction**
35.5 mm ➡ 26.4 mm

Compared with the previous ZH20D☐



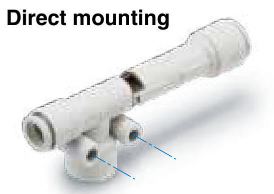

**Weight**
**Max. 74% reduction**
88.4 g ➡ 23.3 g

Compared with the previous ZH20D☐

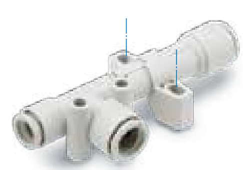



### 4 mounting types

**Direct mounting**



**Standard bracket mounting**



**L-bracket mounting**

**DIN rail mounting**

### Variations

<table>
<tr><th rowspan="2">Model</th><th rowspan="2">Nozzle nominal size [mm]</th><th colspan="2">Ultimate vacuum pressure*1 [kPa]</th><th colspan="2">Max. suction flow rate [L/min (ANR)]</th><th rowspan="2">Air consumption [L/min (ANR)]</th></tr>
<tr><th>Type S</th><th>Type L</th><th>Type S</th><th>Type L</th></tr>
<tr><td>ZH05D☐A</td><td>0.5</td><td rowspan="7">−90</td><td rowspan="4">−48</td><td>6</td><td>13</td><td>13</td></tr>
<tr><td>ZH07D☐A</td><td>0.7</td><td>12</td><td>28</td><td>27</td></tr>
<tr><td>ZH10D☐A</td><td>1.0</td><td>26</td><td>52</td><td>52</td></tr>
<tr><td>ZH13D☐A</td><td>1.3</td><td>40</td><td>78</td><td>84</td></tr>
<tr><td>ZH15D☐A</td><td>1.5</td><td rowspan="3">−66</td><td>58</td><td>78</td><td>113</td></tr>
<tr><td>ZH18D☐A</td><td>1.8</td><td>76</td><td>128</td><td>162</td></tr>
<tr><td>ZH20D☐A</td><td>2.0</td><td>90</td><td>155</td><td>196</td></tr>
</table>

*1 Supply pressure: 0.45 MPa

# In-line Type Vacuum Ejector
## *ZU□A Series*

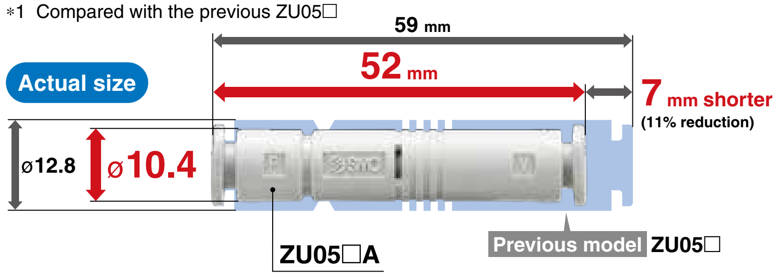
## Compact and lightweight

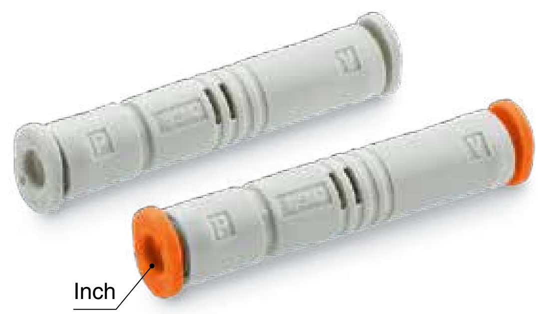
**O.D.**
**ø10.4 mm** *1
Previous model: ø12.8 mm

**Weight**
**3.9 g** *1
Previous model: 6.5 g

**Overall length**
**52 mm** *1
Previous model: 59 mm

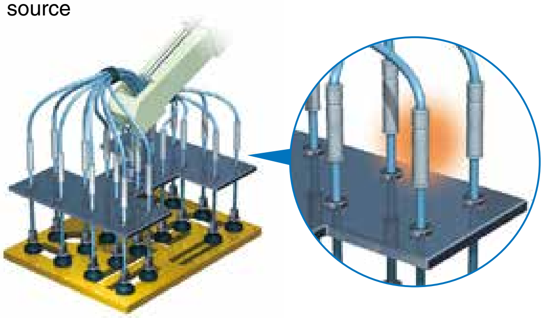
*1 Compared with the previous ZU05□




### Application Examples

For preventing pad adsorption failures from the vacuum source



Numerous pads can be used to adsorb workpieces with holes.

For improving responsiveness by installing on flexible parts

Can be used to open and close plastic bags

For mounting on the end of a Z-axis air cylinder

### Variations

| Model | Nozzle size [mm] | Standard supply pressure [MPa] | Ultimate vacuum pressure [kPa] | | Max. suction flow rate [L/min (ANR)] | | Air consumption [L/min (ANR)] | Port size |
|---|---|---|---|---|---|---|---|---|
| | | | Type S | Type L | Type S | Type L | | |
| ZU03SA | 0.3 | 0.35 | –85 | — | 1.8 | — | 3.7 | ø4 One-touch fitting ø5/32" |
| ZU04SA | 0.4 | | –87 | | 3.2 | | 7.4 | |
| ZU05□A | 0.5 | 0.45 | –90 | –48 | 7 | 13 | 14 | ø6 One-touch fitting Rc1/8 |
| ZU07□A | 0.7 | | | | 11 | 16 | 28 | |

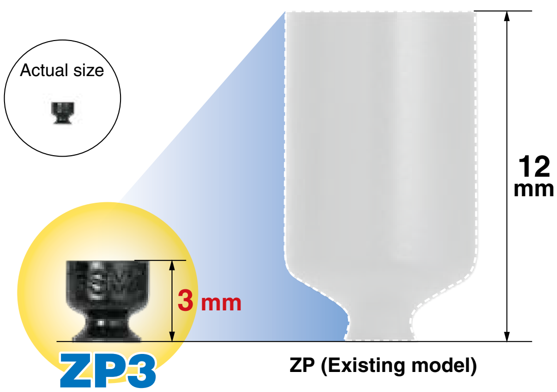
# Vacuum Pad *ZP3 Series*
## ø1.5, ø2, ø3.5, ø4, ø6, ø8, ø10, ø13, ø16

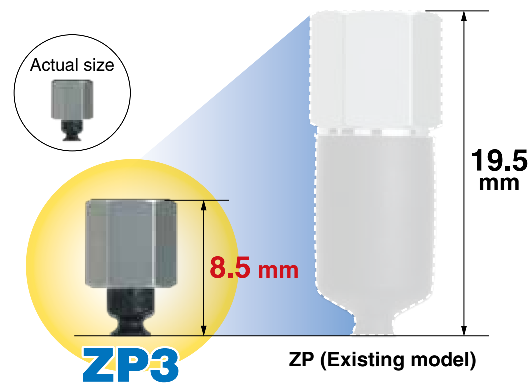
## Overall length shortened

Overall length
Max. 9 mm shorter *1
12 mm ➡ 3 mm
* Pad unit

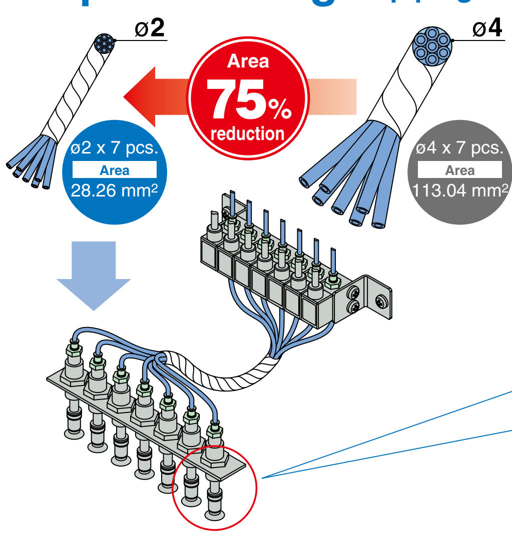
Overall length
Max. 11 mm shorter *1
19.5 mm ➡ 8.5 mm
* With adapter

*1 For the flat type (Pad diameter: ø2)

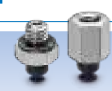


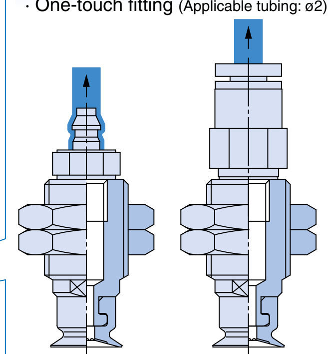

## Space saving ø2 piping reduces working space!



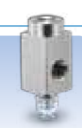

**Vertical**



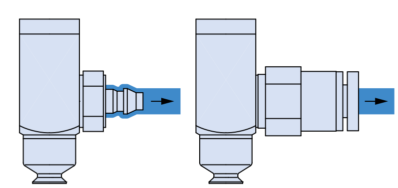
· Male thread
· Female thread
· Barb fitting (Applicable tubing: ø2)
· One-touch fitting (Applicable tubing: ø2)




**Lateral**



· Female thread
· Barb fitting (Applicable tubing: ø2)
· One-touch fitting (Applicable tubing: ø2)




## Variations

| Form | Pad diameter ø1.5 | ø2 | ø3.5 | ø4 | ø6 | ø8 | ø10 | ø13 | ø16 |
|---|---|---|---|---|---|---|---|---|---|
| Flat type  | ● | ● | ● | | | | | | |
| Flat type with groove  | | | | ● | ● | ● | ● | ● | ● |
| Bellows type  | | | | ● | ● | ● | ● | ● | ● |

# One-touch Fittings *KQ2 Series*

**Weight**
Max. 57%[*1] reduction
12 g ➡ 5.2 g

**Height**
Max. 24%[*1] reduction
25.5 mm ➡ 19.4 mm

**Length**
Max. 23%[*1] reduction
20 mm ➡ 15.5 mm

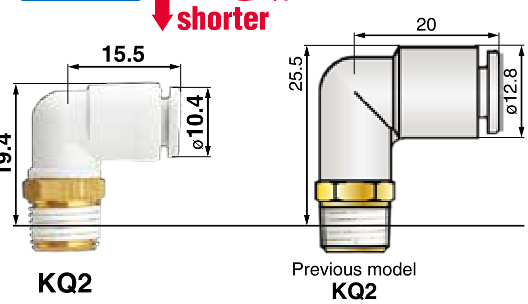
*1 Compared with the previous KQ2 series model: Male elbow, applicable tubing O.D. ø6, connection thread R1/8

## Compact and lightweight

Dimensions Height
24%[*1] shorter

Dimensions Length
23%[*1] shorter

Weight
57%[*1] lighter




*1 Compared with the previous KQ2 series model:
Male elbow, applicable tubing O.D. ø6, connection thread R1/8

## Improved tube insertion/removal

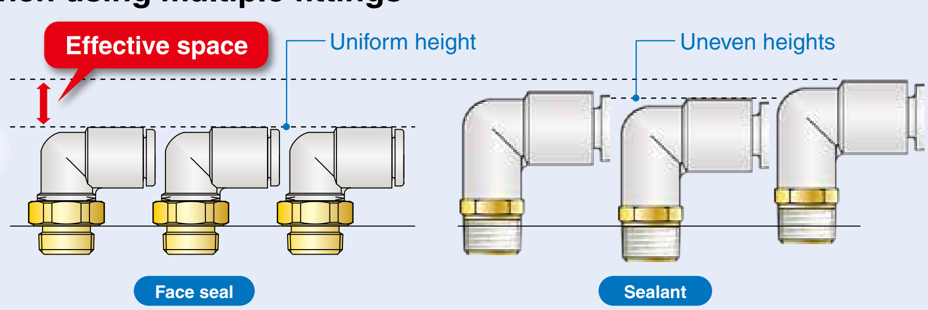

*1 Tube removal strength is ensured to be equivalent to previous model.

### ◎Face seal adopted for threading

**Improved installability** (Reduction in amount of tool-tightening required after hand-tightening)

### ◎Uniform height when using multiple fittings

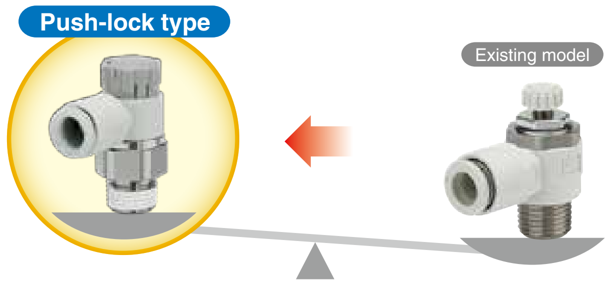
Provides effective space above fittings



# Speed Controller with One-touch Fitting (Push-lock Type) *AS Series*

## Reduced labor time and weight*!*

**Weight**
Reduced by up to approx. **50%**[*1]




*1 Compared with the existing AS22□1F, ø12

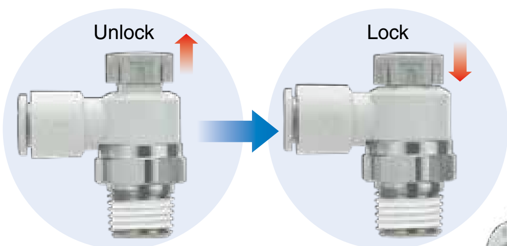
| Tubing O.D. | Thread | Part no. | Weight |
|---|---|---|---|
| ø6 | 1/4 | AS22□1F-02-06A | 18 g |
| ø12 | 1/2 | AS42□1F-04-12A | 56 g |

| Tubing O.D. | Thread | Part no. | Weight |
|---|---|---|---|
| ø6 | 1/4 | AS22□1F-02-06 | 32 g |
| ø12 | 1/2 | AS42□1F-04-12 | 101 g |

Easy to use

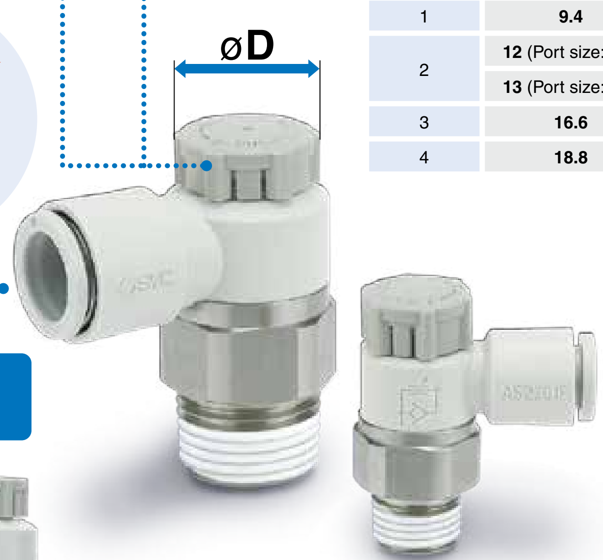
## Push-lock type

- Easy to lock




## Larger knob

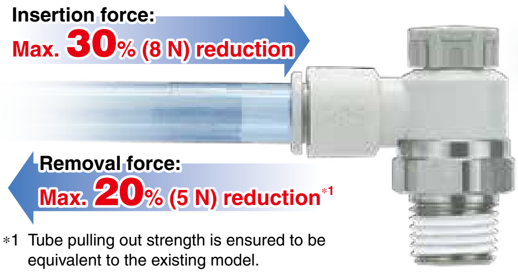
| Body size | øD [mm] |
|---|---|
| 1 | 9.4 |
| 2 | 12 (Port size: 1/8) |
|  | 13 (Port size: 1/4) |
| 3 | 16.6 |
| 4 | 18.8 |




## Improved tube insertion/removal

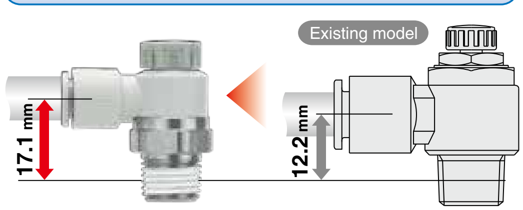
Insertion force:
Max. **30%** (8 N) reduction

Removal force:
Max. **20%** (5 N) reduction[*1]



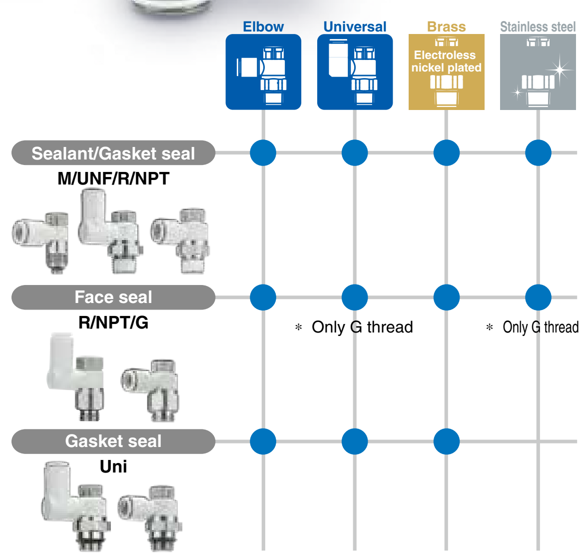
*1 Tube pulling out strength is ensured to be equivalent to the existing model.

More space beneath the tube. Easier installation/removal of the tube.




AS22□1F-02-□SA

AS22□1F-02-□

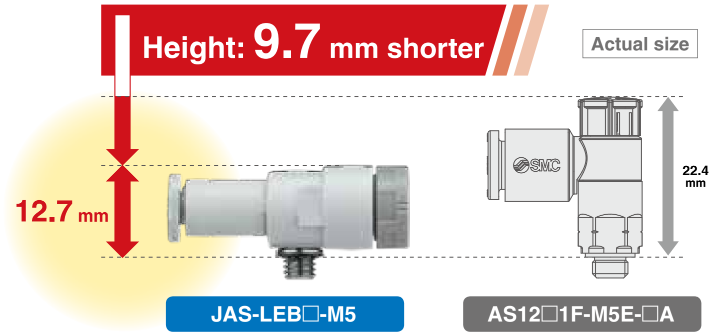


8 Compact and lightweight products

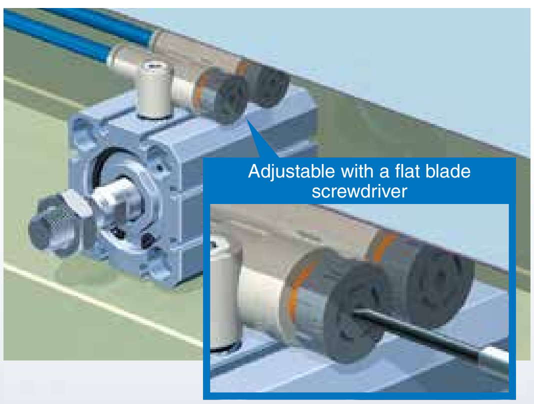
# Speed Controller with One-touch Fitting (Push-lock/Compact Type) *JAS Series*

**Height**
**9.7***1 **mm shorter**
22.4 mm ➡ 12.7 mm

*1 Compared with the existing AS12☐1F, M5

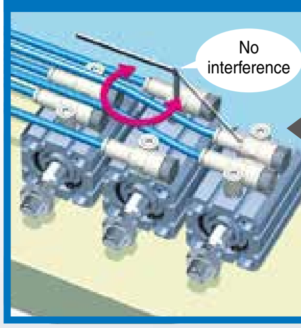



## Possible to adjust flow rate even in a narrow space

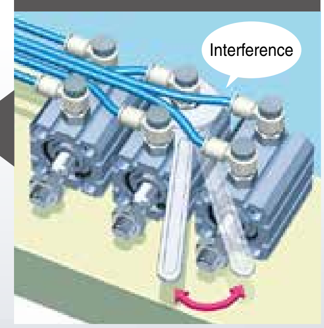



## Easily mounted using a hexagon wrench

**<Compact type>**
Mounting using a hexagon wrench

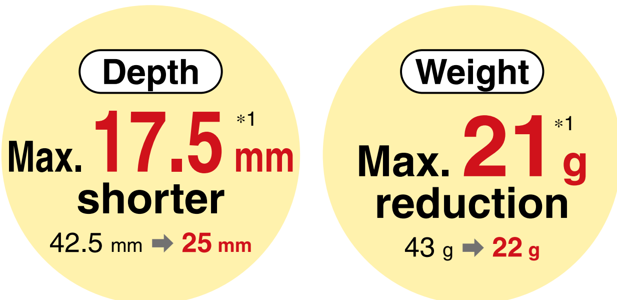



**<Existing model>**
Mounting using a wrench

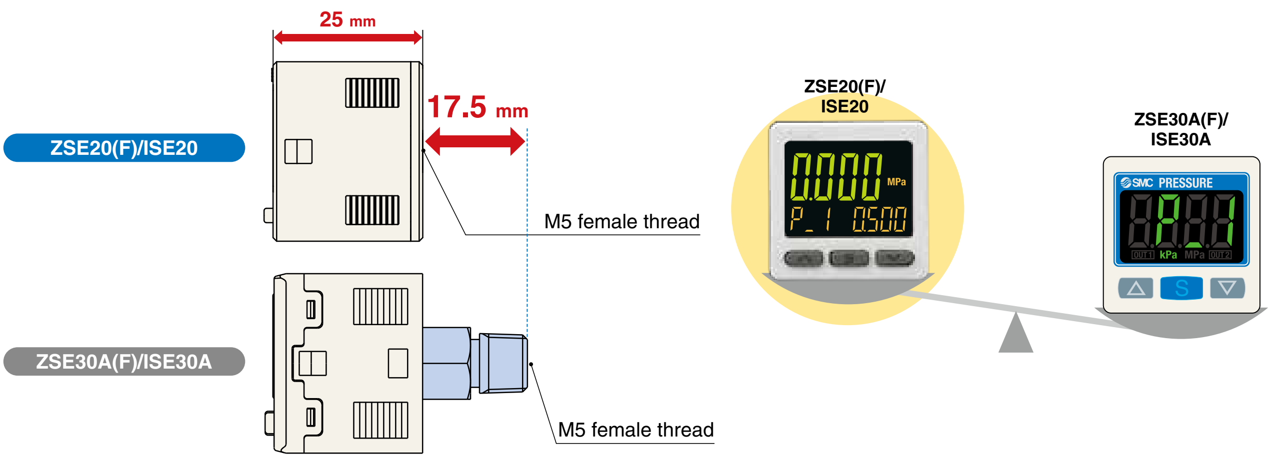



## Minimum operating pressure: 0.05 MPa

# Now more compact and lightweight due to the M5 pressure port being located on the inside of the product




*1 When an M5 female thread is used.

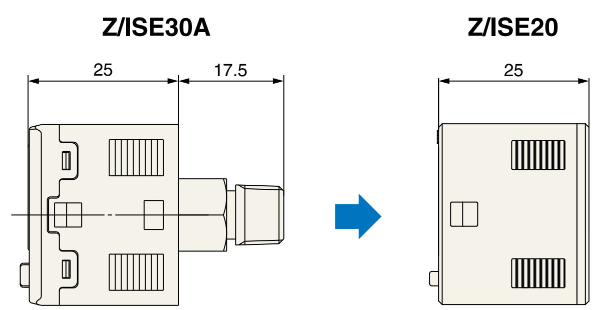



Piping: M5 female thread type

| | Z/ISE20 | Z/ISE30A | Reduction rate |
|---|---|---|---|
| Weight (g) | 22 | 43 | 49% |
| Depth (mm) | 25 | 42.5 | 41% |
| Height (mm) | 30 | 30 | — |
| Width (mm) | 30 | 30 | — |

Piping: R1/8 type

| | Z/ISE20 | Z/ISE30A | Reduction rate |
|---|---|---|---|
| Weight (g) | 32 | 43 | 26% |
| Depth (mm) | 40.2 | 42.5 | 5% |
| Height (mm) | 30 | 30 | — |
| Width (mm) | 30 | 30 | — |



# Digital Flow Switch *PFM□ Series*

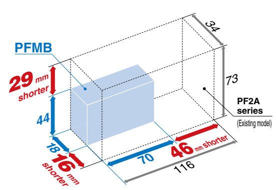
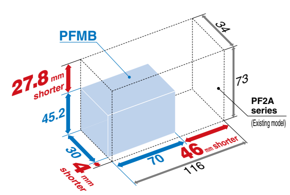
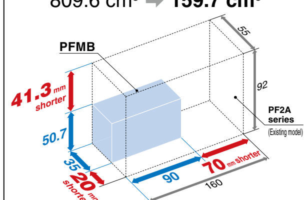
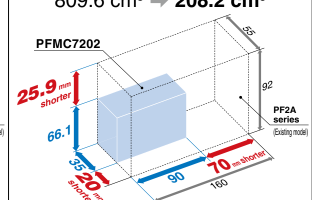
**Volume**
**Max. 81% reduction** *1
287.9 cm³ ➡ **55.4 cm³**

**Weight**
**Max. 86% reduction** *2
1100 g ➡ **155 g**

*1 Compared with the existing PF2A series, 200 L type

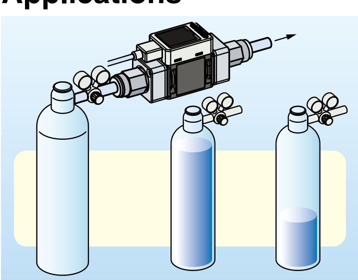
*2 Compared with the existing PF2A series, 2000 L type

## Compared with the Existing PF2A

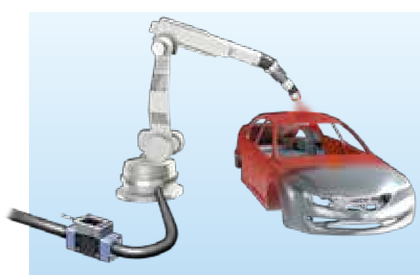
| | PFMB | | | PFMC |
|---|---|---|---|---|
| Series | 200 L type  | 500 L type  | 2000 L type  | 2000 L type  |
| Weight | **76%** reduction<br>290 g ➡ **70 g** | **66%** reduction<br>290 g ➡ **100 g** | **86%** reduction*1<br>1100 g ➡ **155 g** | **78%** reduction<br>1100 g ➡ **240 g** |
| Volume | **81%** reduction<br>287.9 cm³ ➡ **55.4 cm³**<br> | **67%** reduction<br>287.9 cm³ ➡ **94.9 cm³**<br> | **80%** reduction<br>809.6 cm³ ➡ **159.7 cm³**<br> | **74%** reduction<br>809.6 cm³ ➡ **208.2 cm³**<br> |

*1 Compared with the rated flow rate of 3000 L

## Applications

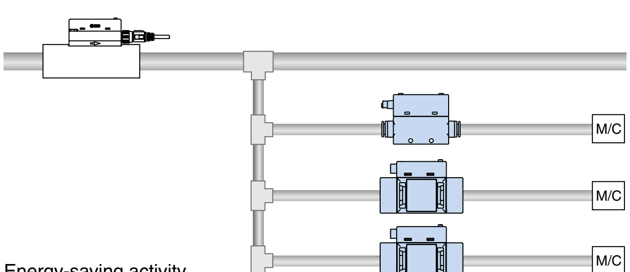


Accumulated indication shows the operating flow rate or residual amount (of $N_2$, etc.) in a gas cylinder.



Flow control of the air for spray painting
* The product is not designed to be explosion proof.

Control of purge air flow of ionizer




Energy-saving activity
(Flow consumption control)

**Flow control for each branch line**

# 9 Technical data



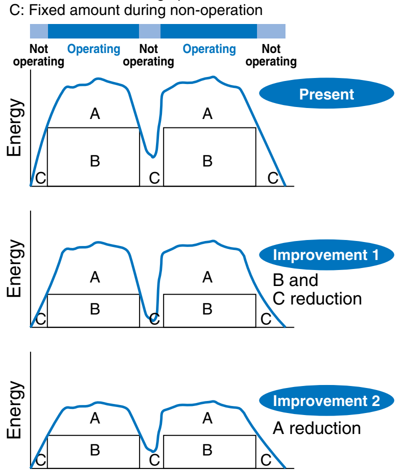
**UNIT CONVERSIONS**

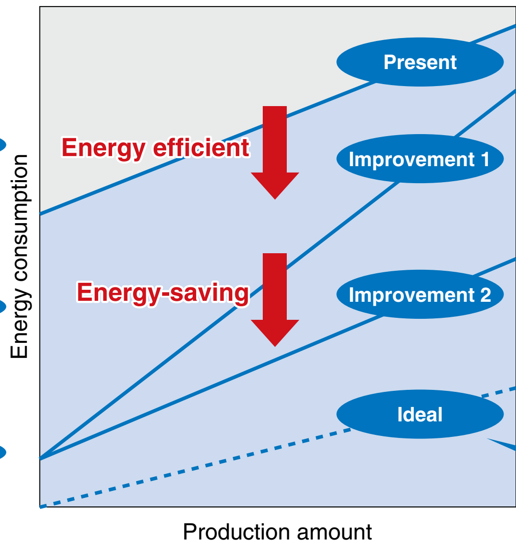
| | unit | conversion | result |
|---|---|---|---|
| length | m | x 3.28 | ft |
| | mm | x 0.04 | in |
| mass | g | x 0.04 | oz |
| volume | $cm^3$ | ÷ 16.387 | $in^3$ |
| | L | x 61.024 | $in^3$ |
| speed | mm/s | ÷ 25.4 | in/s |
| pressure | MPa | x 145 | psi |
| | kPa | ÷ 6.895 | psi |
| temperature | °C | x1.8 then add 32 | °F |
| torque | N·m | x 0.738 | ft-lb |
| force | N | ÷ 4.448 | lbf |
| flow | L/min | ÷ 28.317 | cfm |
| | JPY | x 0.0094 | dollar |

# Energy-saving mindset

**Energy-saving measures can be divided into two main categories. They are either energy efficient or energy saving.**
**Easy-to-implement, effective measures with a priority on energy efficiency can help you take your energy savings to the next level!**

**Factory production examples**
A: Fluctuation amount in proportion to production
B: Fixed amount during operation
C: Fixed amount during non-operation



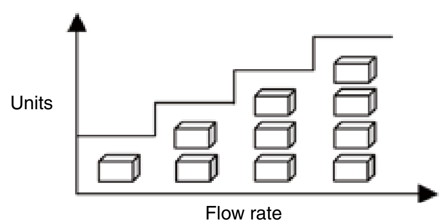
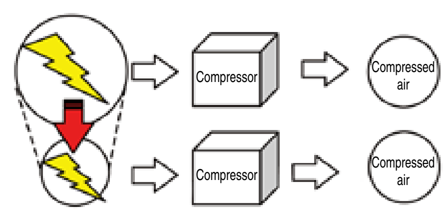
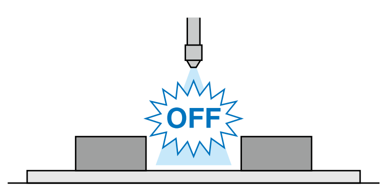
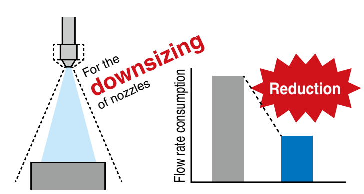
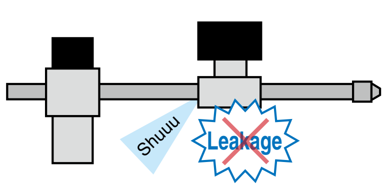
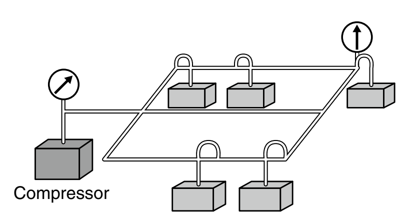




**Energy efficient**
Energy is only used when and where it is required.
Eliminates wasted energy!

**Energy-saving**
Only the required amount of energy is used.
Improves energy usage efficiency!

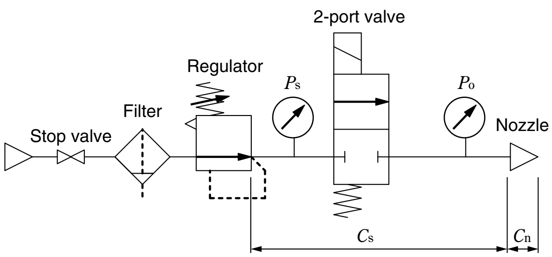
· Consumption in proportion to the min. production ratio
· No air is consumed during non-operation!

## Energy-efficient and energy-saving examples

| | Energy efficient | Energy-saving |
|---|---|---|
| Air pressure source | For the control of multiple units<br> | For reducing the specific power<br> |
| Blow system | For intermittent blow<br> | For adopting smaller nozzles with higher pressure<br> |
| Piping system | For reducing air leakage to 0<br> | For the leveling of pressure with loop piping<br> |

# Changes in upstream conductance pressure loss

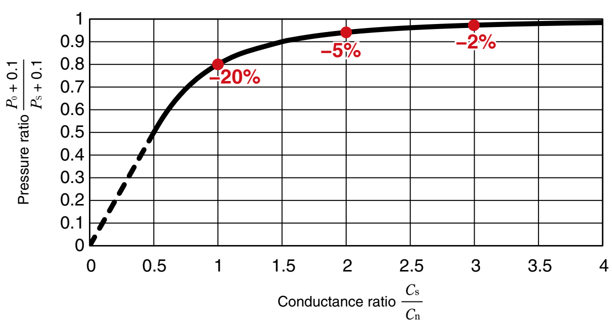
**Since the amount of pressure loss changes depending on the blow nozzle conductance ratio and the upstream (piping, valves, etc.) conductance ratio, the pressure right before the nozzle will also change.**




Recommended air blow system

$P_s$ : Supply pressure
$P_o$ : Pressure right before the nozzle
} Pressure ratio $\frac{P_o + 0.1}{P_s + 0.1}$

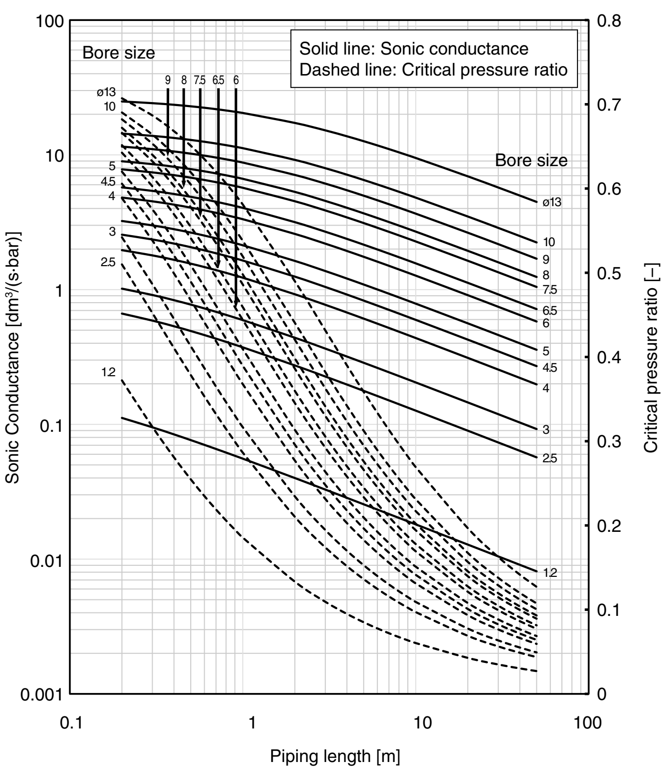
$C_s$ : Upstream conductance
$C_n$ : Nozzle conductance
} Conductance ratio $\frac{C_s}{C_n}$




| Conductance ratio | Pressure drop [%] |
|---|---|
| 1 | 20 |
| 2 | 5 |
| 3 | 2 |

When selecting the size of upstream piping, we recommend staying within 2 to 3 of the conductance ratio.

**Tube conductance example**




**Nozzle conductance example**

| Nozzle size [mm] | $C_n$ | Nozzle size [mm] | $C_n$ |
|---|---|---|---|
| 1 | 0.14 | 3 | 1.27 |
| 1.5 | 0.32 | 3.5 | 1.73 |
| 2 | 0.57 | 4 | 2.26 |
| 2.5 | 0.88 | 6 | 5.09 |
| | | 8 | 9.05 |

**Valve conductance example**

| Body material | Port size | Orifice diameter mmø | Model | Flow rate characteristics C | b |
|---|---|---|---|---|---|
| Al | 1/4 (8A) | 10 | VXD230 | 8.5 | 0.35 |
| | 3/8 (10A) | | | 9.2 | |
| | 1/2 (15A) | | | 9.2 | |
| Resin | ø10 | | | 5.6 | 0.33 |
| | ø3/8" | | | 4.8 | 0.33 |
| | ø12 | | | 7.2 | 0.33 |
| Stainless steel C37 | 3/8 (10A) | 15 | VXD240 | 18.0 | 0.35 |
| | 1/2 (15A) | | | 20.0 | |
| | 3/4 (20A) | 20 | VXD250 | 38.0 | 0.30 |

# Flow rate calculation

**By using the flow rate calculation graph, it is possible to easily calculate the flow rate of a nozzle, tube, or valve.**

## Formula for flow rate

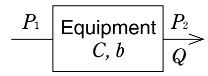
### Choked flow

$$Q = 600 \times C\,(P_1 + 0.1)\sqrt{\frac{293}{273 + T}}$$

### Subsonic flow

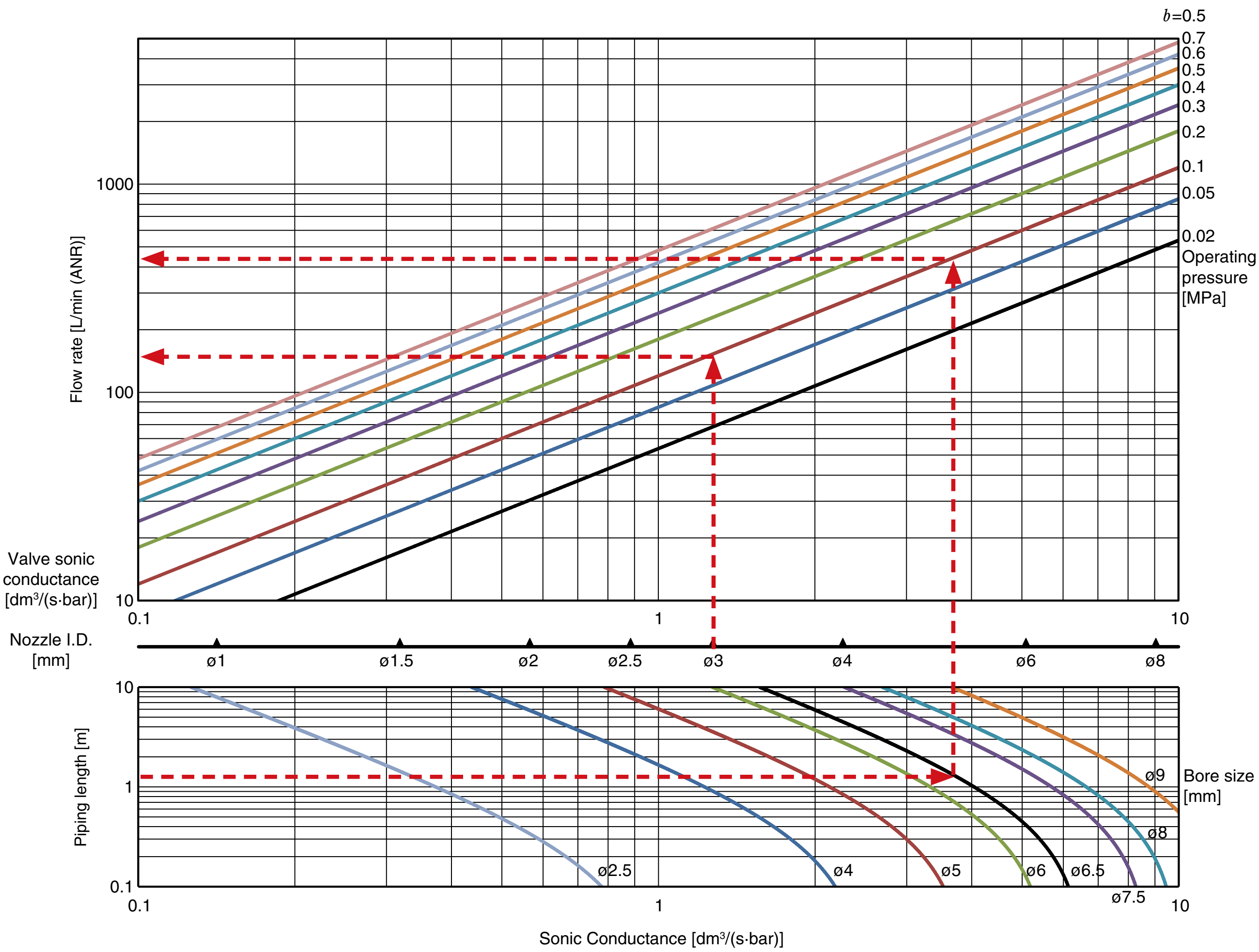
$$Q = 600 \times C\,(P_1 + 0.1)\sqrt{1-\left[\frac{\frac{P_2 + 0.1}{P_1 + 0.1}-b}{1-b}\right]^2}\sqrt{\frac{293}{273 + T}}$$

When the critical pressure ratio is 0.5




$Q$ : Air flow rate [L/min (ANR)]
$C$ : Sonic conductance [L/(s·bar)]
$b$ : Critical pressure ratio [–]
$P_1$: Upstream pressure [MPa]
$P_2$: Downstream pressure [MPa]
$T$ : Temperature [°C]

## Flow rate calculation graph




## Calculation example

### For nozzles

① Go up in a vertical line from the nozzle I.D.
② From the point of intersection with the operating pressure (diagonal line), go horizontally to the left to find the flow rate.

### For tubes

① Find the point of intersection of the tube I.D. (diagonal line) and the piping length, and go up in a vertical line.
② From the point of intersection with the operating pressure (diagonal line), go horizontally to the left to find the flow rate.

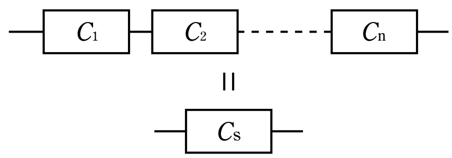
# Conductances combined

## Calculation method for combining the conductance of each device and finding the equivalent conductance of each device in order to figure out the flow capacity of a pneumatic system

### Formula for finding the combined total

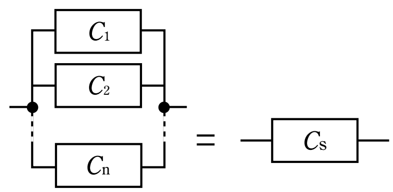
**Connected in series**

$$C_s = \frac{1}{\sqrt[3]{\frac{1}{C_1^3} + \frac{1}{C_2^3} + \dots + \frac{1}{C_n^3}}}$$



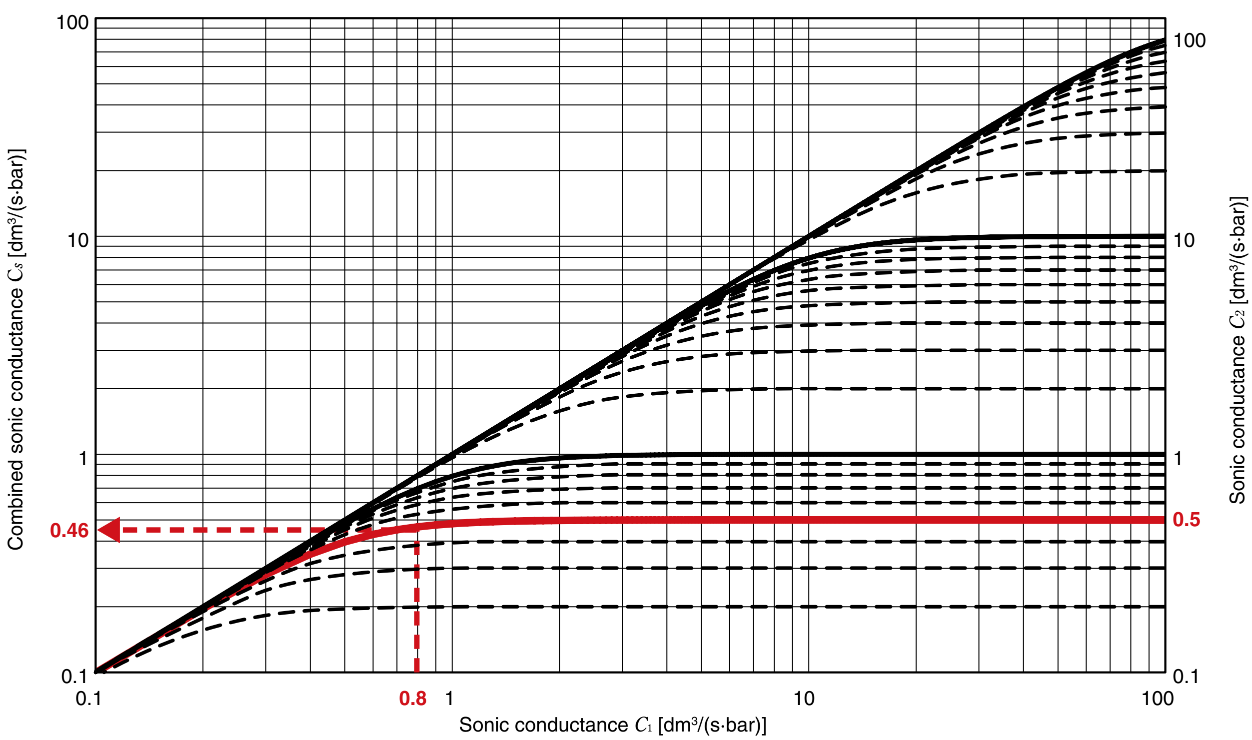

**Connected in parallel**

$$C_s = C_1 + C_1 + \dots + C_n$$




There is also a formula for finding the critical pressure ratio ($b$), but it's easier to just use the smallest device possible.

### Graph for when connected in series



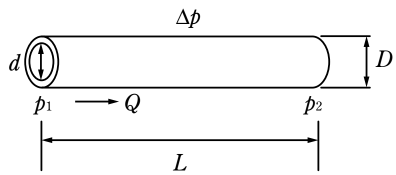

Ex.) When connecting a device (sonic conductance: $C_1$ = 0.8) to another device (sonic conductance: $C_2$ = 0.5), 0.46 is required.

# Main piping pressure loss calculation

## Pressure loss formula

Pressure loss $\Delta p$

$$\Delta p = \frac{2.466 \times 10^3 L}{d^{5.31}\ (p_1 + 0.1)} Q^2$$




$\Delta p$ : Pressure loss [MPa] (= $p_1 - p_2$)

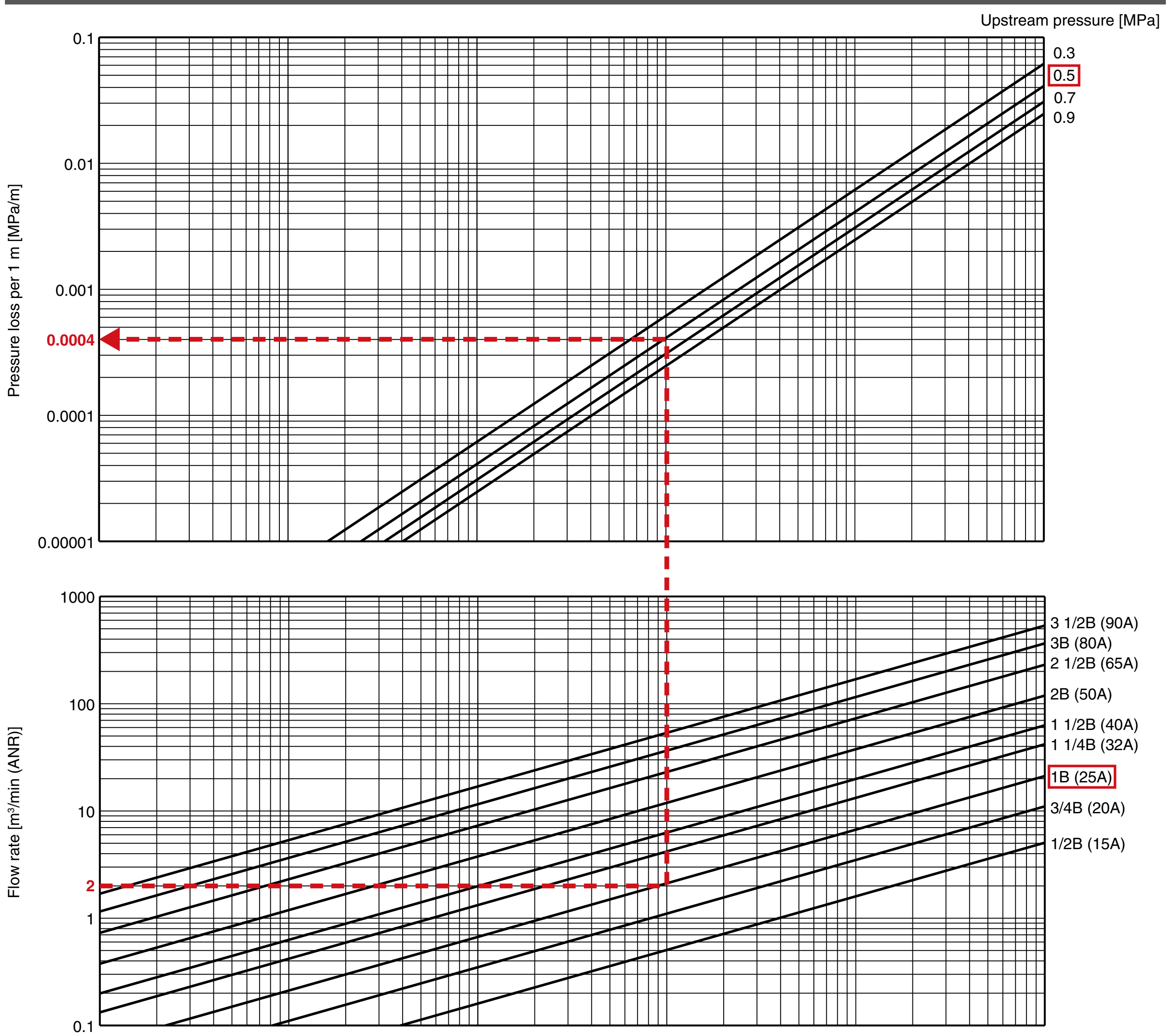
$Q$ : Standard volume flow [$m^3$/min (ANR)]

$p_1$ : Upstream pressure [MPa] (= Gauge pressure)

$d$: Pipe bore [mm]

$L$: Piping length [m]

## Pressure loss calculation graph



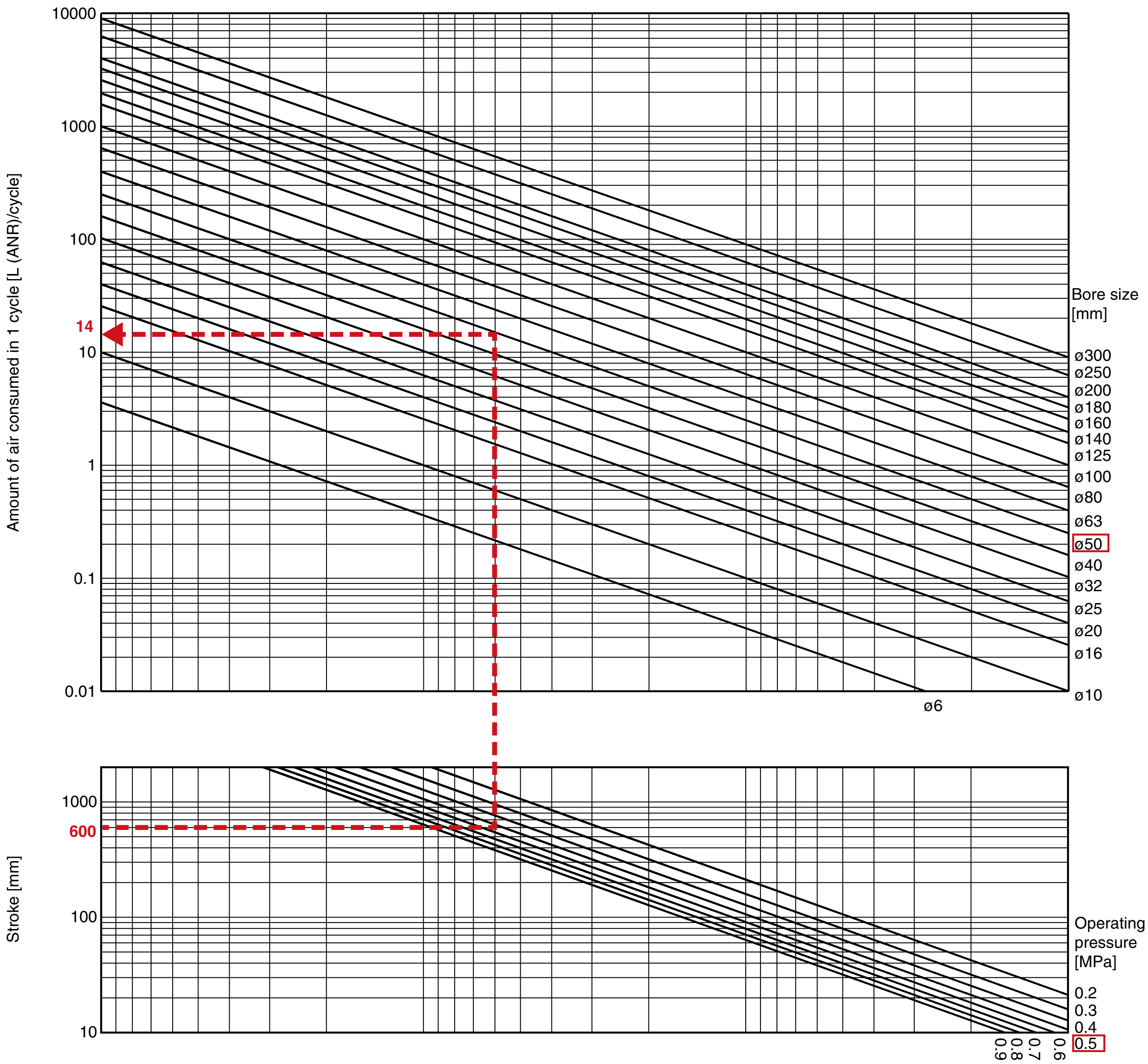

## Calculation example

For 1B (25A), $L$ = 10 m, $p_1$ = 0.5 MPa, and $Q$ = 2 $m^3$/min (ANR), the pressure loss per 1 m can be found to be 0.0004 [MPa/m] and, therefore, for 10 m, it is $\Delta p$ = 0.0004 x 10 = 0.004 [MPa].

# Amount of air consumed by the cylinder and tubing 1

**By using the graph, it is possible to easily calculate the amount of air consumed by a cylinder and the tubing in 1 cylinder cycle.**

## Graph for finding the amount of air consumed by the cylinder in 1 cycle




## How to find the amount of air consumed by the cylinder

How much air is consumed in 1 cycle when 10 cylinders (Bore size: 50 mm, Stroke: 600 mm) are operated at a pressure of 0.5 MPa?

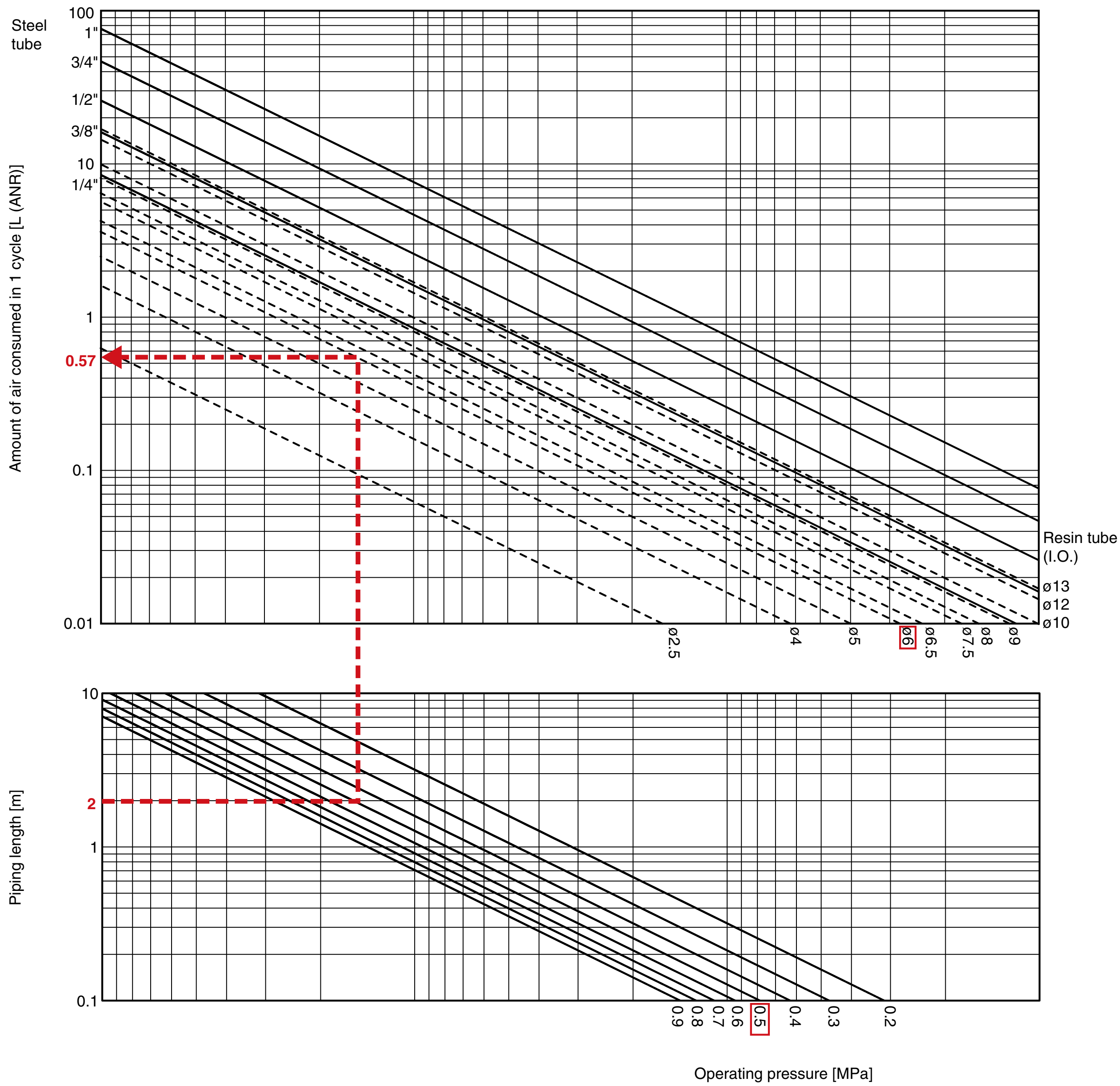
①Find the point of intersection of the operating pressure (diagonal line) and the stroke length, and go up in a vertical line.

②From the point of intersection with the tube I.D. (diagonal line), go horizontally to the left to find the amount of air required for 1 cylinder cycle.

③Furthermore, by multiplying this number by 10, the amount of air required for 1 cycle of 10 cylinders can be found.

# Amount of air consumed by the cylinder and tubing 2

## Graph for finding the amount of air consumed by the tubing in 1 cylinder cycle




## How to find the amount of air consumed by the tubing

How much air is consumed in 1 cycle of a cylinder operating at a pressure of 0.5 MPa when 2 tubes (I.D.: 6 mm, Piping length: 2 m) are used?

① Find the point of intersection of the operating pressure (diagonal line) and the piping length, and go up in a vertical line.

② From the point of intersection with the tube I.D. (diagonal line), go horizontally to the left to find the amount of air consumed by the tubing in 1 cylinder cycle.

## How to find the total amount of air consumed

The amount air consumed by the cylinder and tubing can be found using the formula below.

Total air consumption = (the amount of air consumed by the cylinder in 1 cycle + the amount of air consumed by the piping in 1 cylinder cycle) x the number of operations

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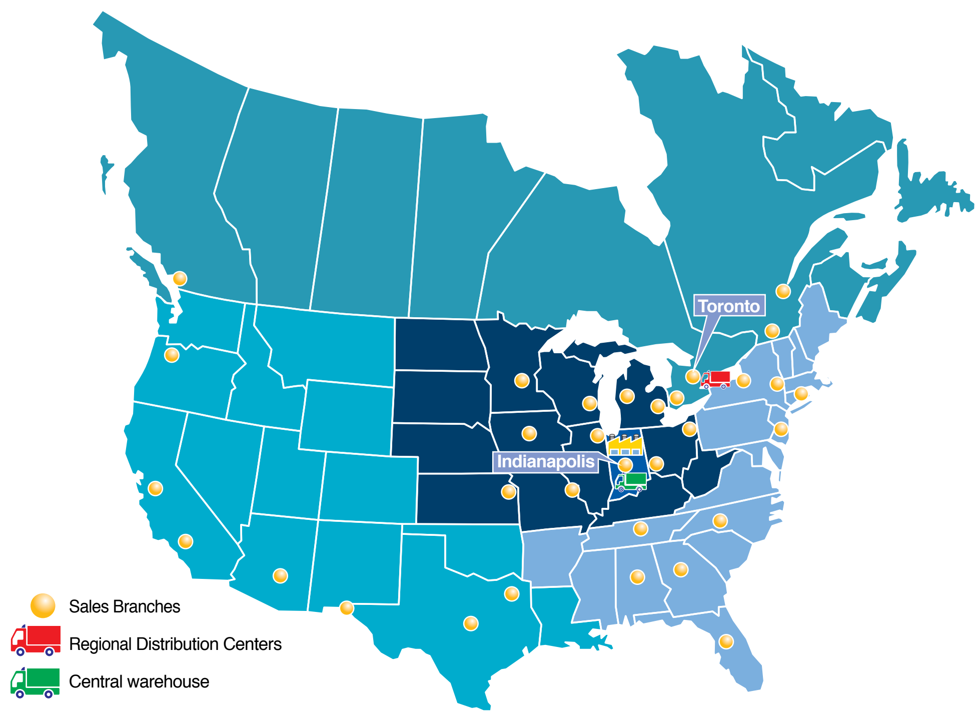



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