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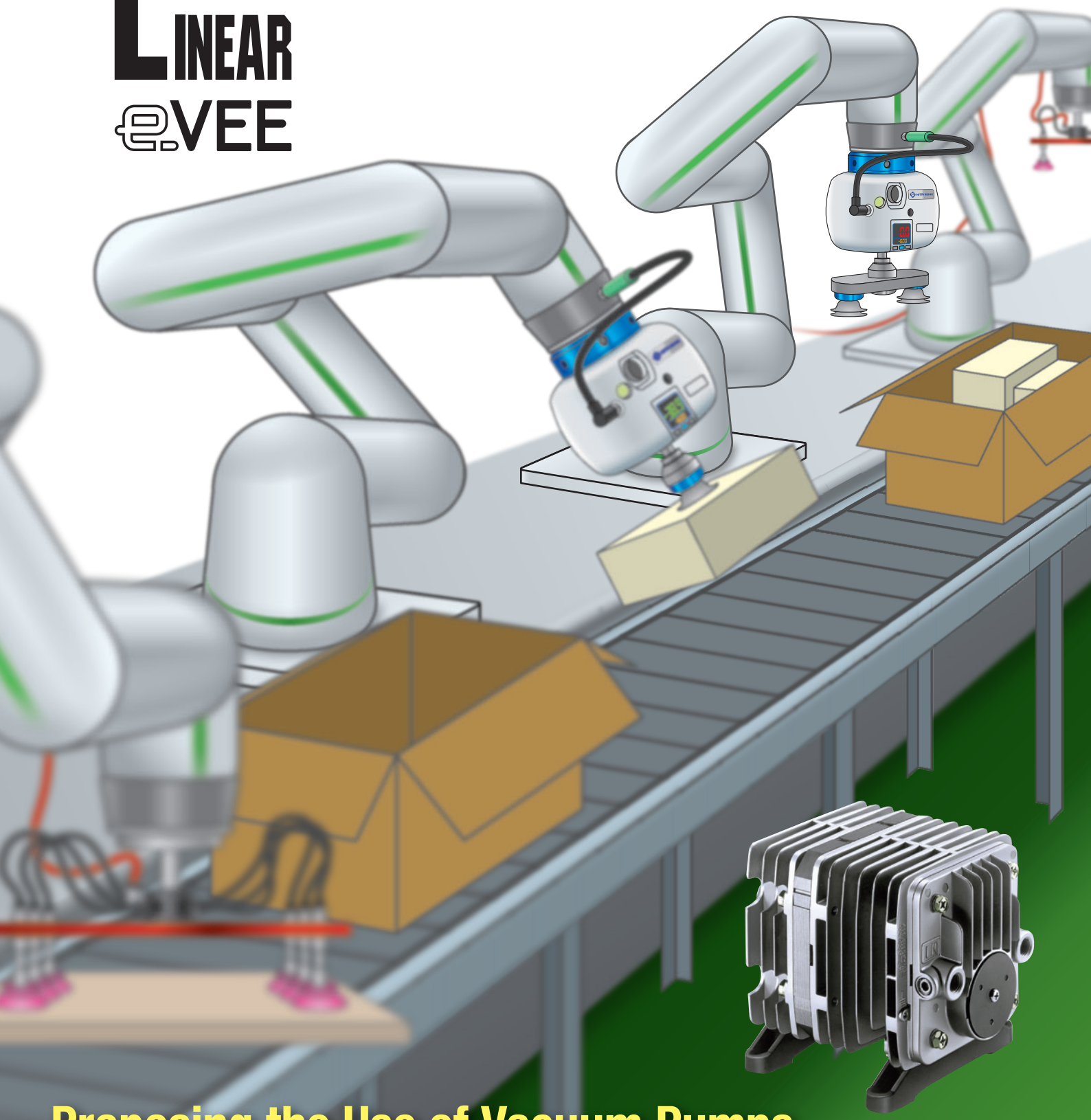
X19en

Nitto Kohki Energy-Saving Products Catalog

Toward Carbon Neutrality:
Energy-Saving Solutions for the Industry

LINEAR

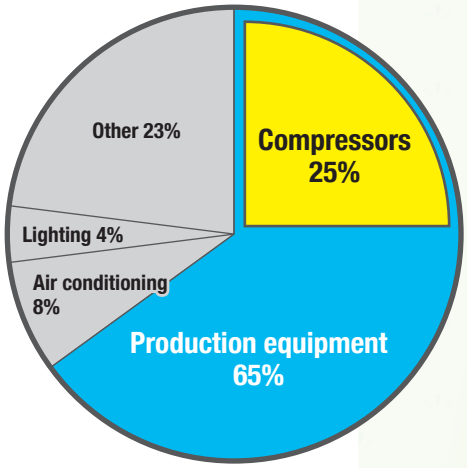
eVEE



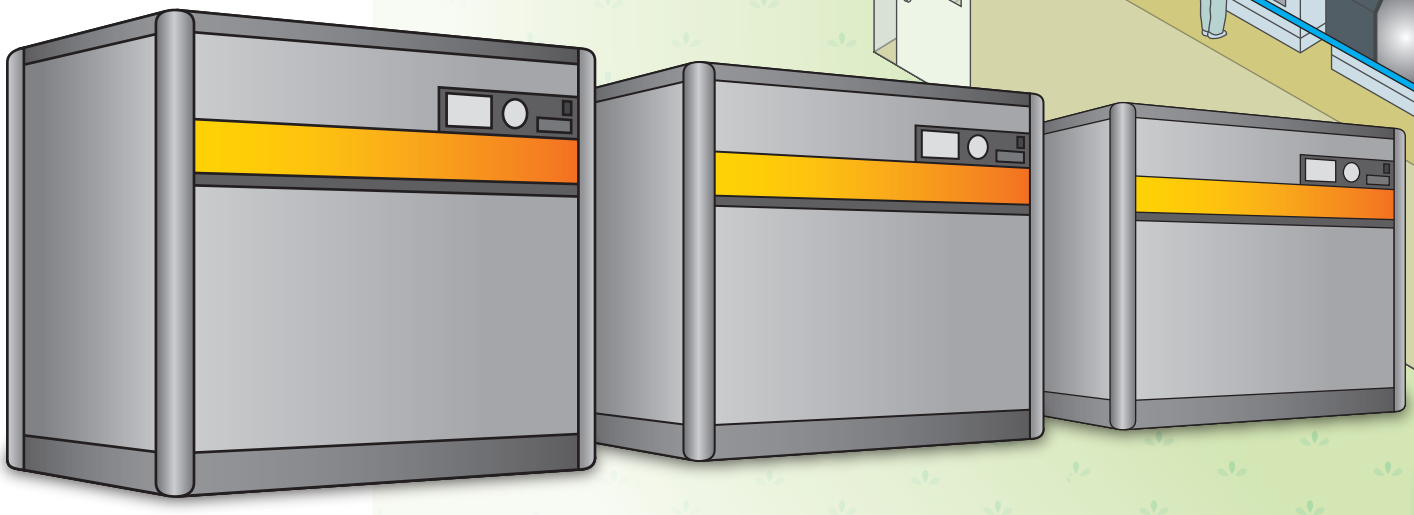
Proposing the Use of Vacuum Pumps as Vacuum Sources for Suction-Based Material Handling

To Promote Energy Saving in Factories

Breakdown of Electricity Consumption in Factories



In a typical factory, 65% of total electricity is consumed by production equipment.
Among these, compressed air is used for a wide range of applications, including machine tools, product handling, and cleaning. As a result, compressors account for 25% of total electricity use.
Therefore, **reducing compressor power consumption helps reduce overall electricity use in factories.**



Energy-Saving Measures for Compressors

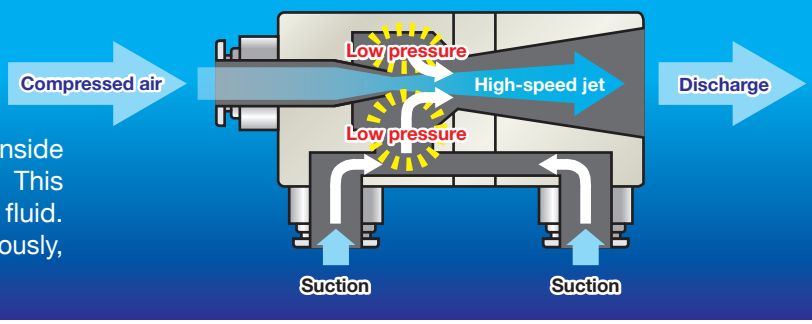
- **Reducing air leakage**
- **Reducing discharge pressure and flow rate**
- **Lowering intake air temperature**
  Example: A 5°C reduction in intake temperature saves about 1% of energy.
  (According to the Boyle-Charles Law)
- **Other measures**
  - Regular cleaning and maintenance of filters
  - Introducing multi-unit control or inverter control
  - Switching to high-efficiency compressors
  - Stopping compressors during non-production hours

Switching vacuum sources for vacuum lifting

In conventional vacuum lifting systems using ejectors, a continuous supply of compressed air is required to maintain vacuum.
By switching from an ejector to a vacuum pump, it is possible to reduce power consumption.

What is an ejector?

An ejector generates a low-pressure zone inside the unit by jetting fluid at high speed. This creates a suction force that draws external fluid. As compressed air must be supplied continuously, air consumption increases.

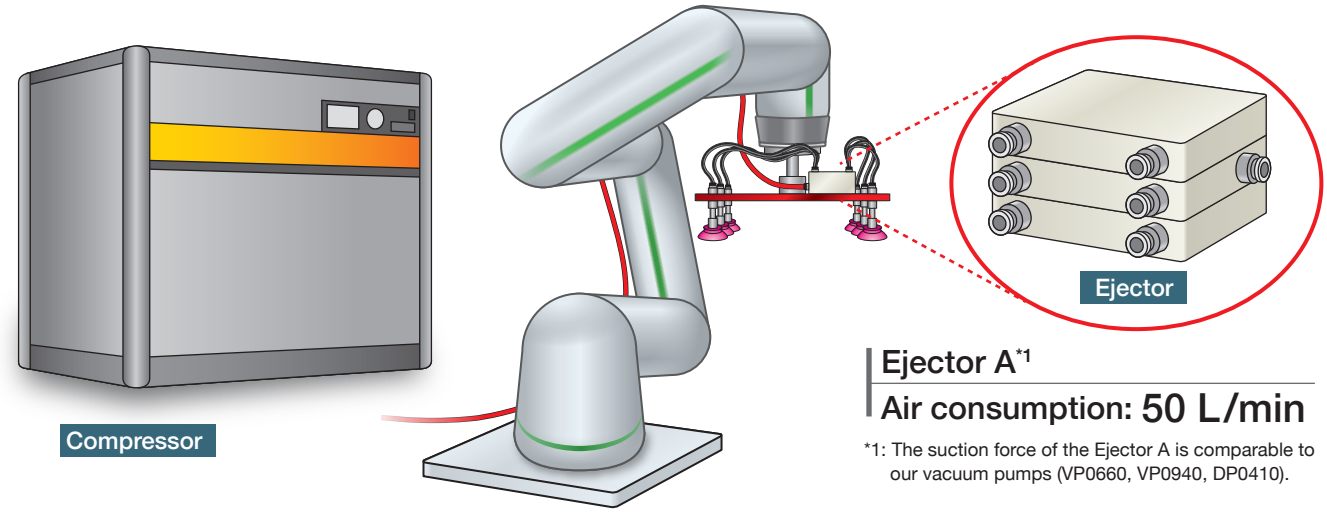


Power Consumption Calculation

Vacuum source:
Ejector (Air consumption: 50 L/min)

Vacuum lifting system components

Compressor | Ejector | Vacuum gripper | Material-handling robot



Ejector A*1
Air consumption: 50 L/min

*1: The suction force of the Ejector A is comparable to our vacuum pumps (VP0660, VP0940, DP0410).

Specifications

Compressor

Power Consumption	30931 W *2
Motor Output	37000 W
Rated Discharge Pressure	0.74 MPa
Discharge Airflow	6300 L/min

Ejector A

Maximum Vacuum Pressure	-75 kPa
Air Consumption	50 L/min
Supply Pressure	0.45 MPa

Power Consumption per Ejector

Air consumption ratio of Ejector A = Ejector A air consumption ÷ Compressor discharge airflow

50 L/min ÷ 6300 L/min = 0.0079365

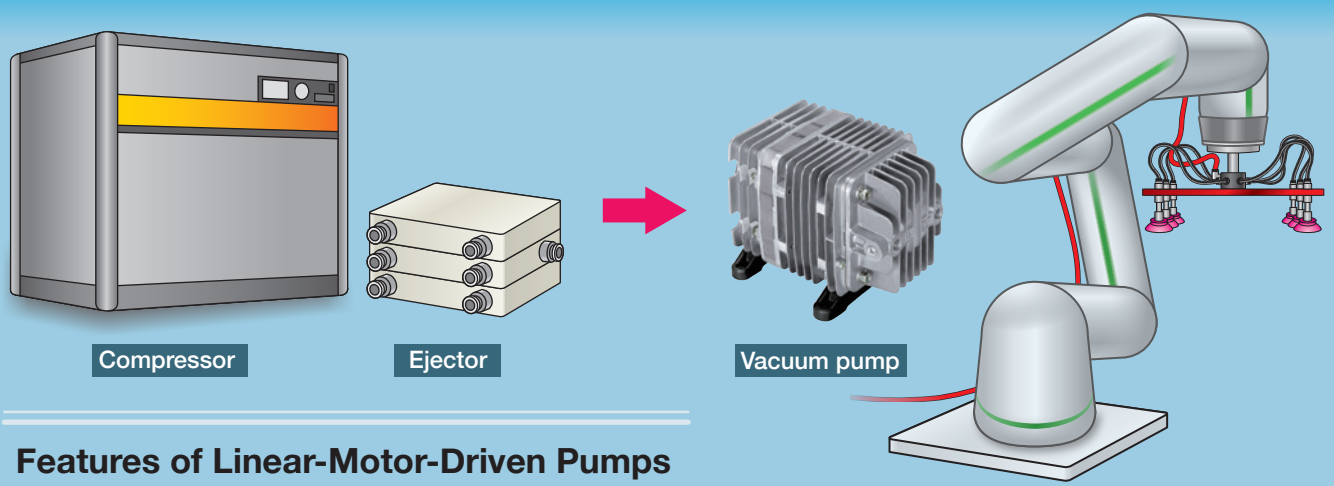
Power consumption of Ejector A = Compressor power consumption × Air consumption ratio of Ejector A

30931 W × 0.0079365 = 245.48388 W

Approximately **245.5 W**

*2: Calculated based on motor efficiency and power ratio.

By switching from an ejector-and-compressor system to a vacuum pump as the vacuum source for vacuum lifting, air consumption can be reduced.



Features of Linear-Motor-Driven Pumps

- Can be turned ON and OFF in a closed circuit (linear drive type)
- Can restart without lowering the vacuum level (no atmospheric release required)

Vacuum level	-50 kPa to -80 kPa
Flow Rate	25 L/min to 120 L/min
Power Consumption	36 W to 95 W

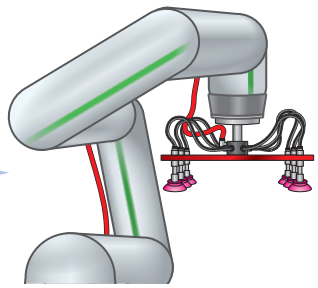
Power Consumption Calculation

Vacuum source:
Vacuum pump (Air consumption: 18 to 60 L/min)

Vacuum lifting system components

Vacuum pump | Vacuum gripper | Material-handling robot

Vacuum pump
VP0660



Up to 76% reduction in power consumption

Specifications: VP0660

Rated Voltage	115 V AC	230 V AC
Attainable Vacuum	-80 kPa (-600 mmHg) -800 mbar -23.6 in.Hg	
Free Air Displacement	25 L/min 0.88 cfm	
Power Consumption	70 W	60 W

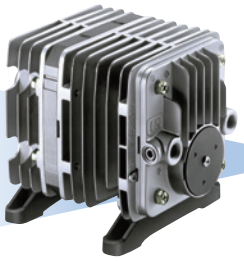
Power Consumption Comparison Between Ejector and Vacuum Pump

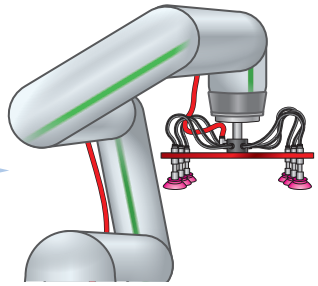
Comparison with Ejector A = Power consumption of VP0660 ÷ Power consumption of Ejector A (245.5 W)

70 W (115 V AC) ÷ 245.5 W = 0.2851323 (115 V AC)
60 W (230 V AC) ÷ 245.5 W = 0.2443991 (230 V AC)

▶ Approximately 29% (115 V AC), 24% (230 V AC)

Vacuum pump
VP0940





Up to 61% reduction in power consumption

Specifications: VP0940

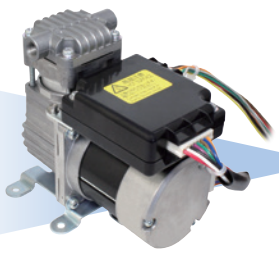
Rated Voltage	115 V AC	230 V AC
Attainable Vacuum	-53.3 kPa (-400 mmHg) -533 mbar -15.7 in.Hg	
Free Air Displacement	60 L/min 2.12 cfm	
Power Consumption	95 W	

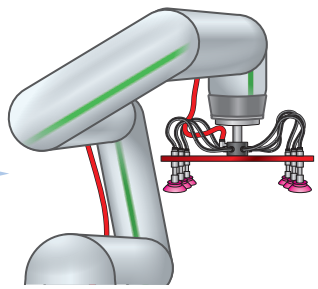
Power Consumption Comparison Between Ejector and Vacuum Pump

Comparison with Ejector A = Power consumption of VP0940 ÷ Power consumption of Ejector A (245.5 W)

95 W ÷ 245.5 W = 0.3869653 ▶ Approximately 39%

Vacuum pump
DP0410





Up to 85% reduction in power consumption

Specifications: DP0410

Rated Voltage	12 V DC	24 V DC
Attainable Vacuum	-77.3 kPa (-580 mmHg) -773 mbar -22.8 in.Hg	
Free Air Displacement	18 L/min 0.64 cfm	
Power Consumption	36 W	

Power Consumption Comparison Between Ejector and Vacuum Pump

Comparison with Ejector A = Power consumption of DP0410 ÷ Power consumption of Ejector A (245.5 W)

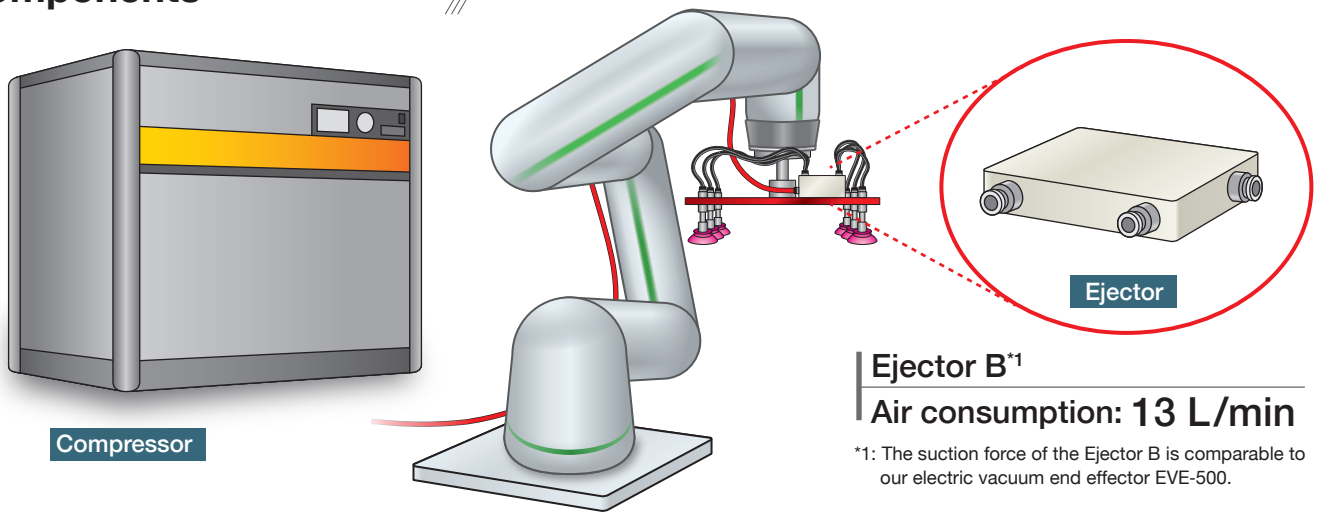
36 W ÷ 245.5 W = 0.1466395 ▶ Approximately 15%

Power Consumption Calculation

Vacuum source:
Ejector (Air consumption: 13 L/min)

Vacuum lifting system components

Compressor | Ejector | Vacuum gripper | Material-handling robot



Ejector B*1
Air consumption: 13 L/min

*1: The suction force of the Ejector B is comparable to our electric vacuum end effector EVE-500.

Specifications

Compressor

Power Consumption	30931 W *2
Motor Output	37000 W
Rated Discharge Pressure	0.74 MPa
Discharge Airflow	6300 L/min

Ejector B

Maximum Vacuum Pressure	-48 kPa
Air Consumption	13 L/min
Supply Pressure	0.45 MPa

Power Consumption per Ejector

Air consumption ratio of Ejector B = Ejector B air consumption ÷ Compressor discharge airflow

13 L/min ÷ 6300 L/min = 0.0020634

Power consumption of Ejector B = Compressor power consumption × Air consumption ratio of Ejector B

30931 W × 0.0020634 = 63.823025 W

▶ Approximately **63.8 W**

*2: Calculated based on motor efficiency and power ratio.

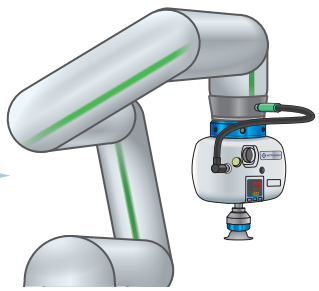
Power Consumption Calculation

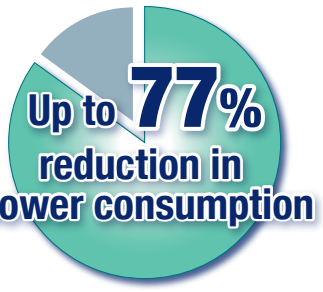
Vacuum source:
Vacuum pump (Air consumption: 7.5 L/min)

Vacuum lifting system components

Electric Vacuum End Effector (Build-in vacuum pump) | Vacuum gripper | Material-handling robot

YouTube





Specifications: EVE-500

Rated Voltage	24 V DC
Attainable Vacuum	-66.6 kPa (-500 mmHg) -666 mbar -19.7 in.Hg
Free Air Displacement	7.5 L/min 0.265 cfm
Power Consumption	14.4 W

Power Consumption Comparison Between Ejector and Vacuum Pump

Comparison with Ejector B = Power consumption of EVE-500 ÷ Power consumption of Ejector B (63.8 W)

14.4 W ÷ 63.8 W = 0.2257053 ▶ Approximately **23%**

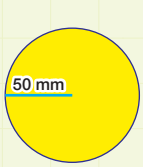
How to Calculate Lifting Force

Lifting force = Area x Degree of vacuum x Safety factor

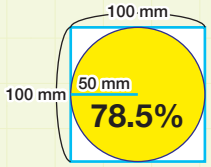
YouTube

Area

- The area of a circle is calculated using radius × radius × 3.14.
  When the length of a square's side is equal to the diameter of the circle, the area of the circle is 78.5 % of the area of the square.
  Therefore, the area of a circle can be calculated using diameter² x 0.785.



50 × 50 × 3.14 = 7850 ➡ 100 × 100 × 0.785 = 7850



Degree of vacuum

- The degree of vacuum is the amount of pressure reduced from 1 atmosphere.
- One atmosphere (101.3 kPa) is the atmospheric pressure at sea level, which applies a force of 1.033 kg on an area of 1 cm². When the pressure is reduced to an absolute vacuum (0 kPa), a lifting force of 1.033 kg acts on 1 cm².

1 atmosphere
(101.3 kPa)

Unit Conversion

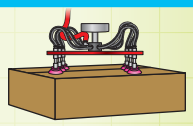
- To calculate lifting force in g/cm², convert the units.
- To convert kPa to kg/cm², divide the degree of vacuum by the ratio of atmospheric volume per 1 atmosphere (101.3 kPa ÷ 1.033 kg = 98.063891, approximately 98.1)

x kPa ÷ 98.1 = y kg/cm²

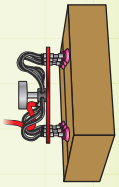
- kg × 1000 = g
- mm² × $\frac{1}{100}$ = cm²

Safety Factor

For horizontal lifting
1/4 = 0.25



For vertical lifting
1/8 = 0.125



Lifting force (g) =

Diameter (mm) × Diameter (mm) × 0.785 × Degree of vacuum (kPa) ÷ 98.1 × 1000 × $\frac{1}{100}$ × Safety factor

(Convert kg to g; Convert mm² to cm²)

= (Diameter (mm)² × 7.85) × (Degree of vacuum (kPa) ÷ 98.1) × Safety Factor

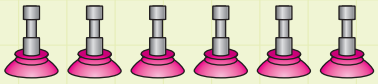
Example:

Lifting force when transporting horizontally with
6 suction cups (ϕ35) and VP0940 (degree of vacuum: -53.3 kPa)

$35^2 \times 7.85 \times 53.3 \div 98.1 \times 0.25 = 1306.1827$

1306.1827 × 6 (Suction cups) = 7837.0962

➡ Approximately **7837 g**



Suction cups (Φ35) × 6 pcs

VP0940
(Degree of vacuum: -53.3 kPa)

The linear vacuum pump series offers sufficient performance for vacuum lifting applications while maintaining low power consumption.
With a wide range of models available, it is easy to find the right pump for your needs.

Vacuum Pump Specifications

Drive System	Model	Attainable Vacuum (kPa)	Free Air Displacement (L/min)	Power Consumption (W)	Rated Voltage (V)
Linear drive	VP0660	-80	25	70/60	115/230
	VP0940	-53.3	60	95	
	VP0940T	-53.3	120	185	230
DC drive	DP0410-X1	-77.3	18	60	12
	DP0410-Y1	-77.3	18	36	24
	DP0410T-Y1	-77.3	34	60	
	EVE-500	-66.6	7.5	14.4	

Method for Calculating Power Reduction Compared with Ejectors

Vacuum Pumps VP0660 / VP0940
If we assume an air consumption of 50 L/min for an ejector with performance comparable to the VP0660 and VP0940 (maximum vacuum pressure: -75.5 kPa, suction flow: 31 L/min), the compressor power consumption per ejector is calculated to be 245.5 W. This value is based on the flow ratio of a large compressor (motor output 37000 W, discharge airflow 6300 L/min), taking motor efficiency and power ratio into account.
Compared to the power consumption of VP0660 (65 W) and VP0940 (95 W), power consumption is reduced by 76% and 61%, respectively.

Electric Vacuum End Effector e-VEE
If we assume an air consumption of 32.2 L/min for an ejector with performance comparable to the EVE-500 (maximum vacuum pressure: -48 kPa, suction flow: 13 L/min), the compressor power consumption per ejector is calculated to be 63.8 W. This value is based on the flow ratio of a large compressor (motor output 37000 W, discharge airflow 6300 L/min), taking motor efficiency and power ratio into account.
Compared to the power consumption of the EVE-500 (14.4 W), power consumption is reduced by 77%.

Cutting Oil Collecting Unit HK-400A
If we assume an air consumption of 20 L/min for a process pump with performance comparable to the HK-400A (suction flow: 2 L/min), the compressor power consumption per pump is calculated to be 55.9 W. This value is based on the flow ratio of a large compressor (motor output 37000 W, discharge airflow 6300 L/min), taking motor efficiency and power ratio into account.
Compared to the power consumption of the HK-400A (10.8 W), power consumption is reduced by 81%.

Energy-Saving Measures for Compressors

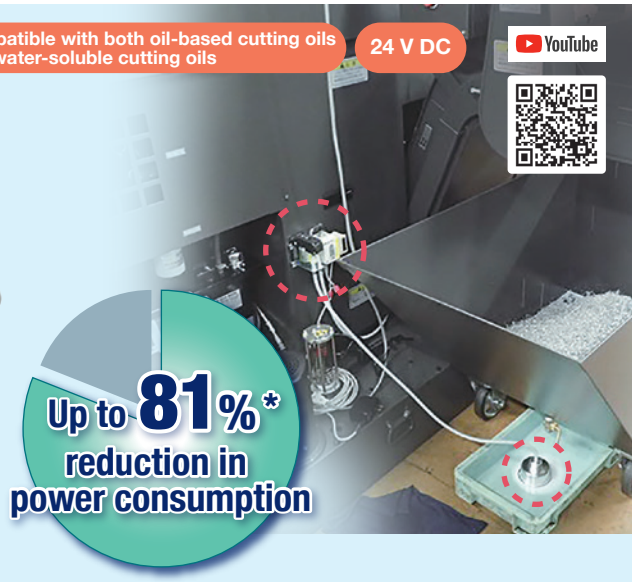
Cutting oil collecting unit | HK-400A

The HK-400 collects small amounts of cutting oil spilled from machine tools

Compatible with both oil-based cutting oils and water-soluble cutting oils

24 V DC

YouTube



Specifications

Self-priming Pressure	40 kPa
Flow Rate	400 mL/min
Power Consumption	10.8 W

- Can be installed on the side of machine tools with the magnet.
- No air piping required.
  Save energy by switching from ejectors.
- Comes with a strainer to prevent suction of cutting chips
- Capable of suction of mixed gas and liquid, no risk of burning out the motor when idling.

No compressed air required by switching from a process pump.

*Compared with a process pump of equivalent performance.
*Air consumption per process pump: 20 L/min

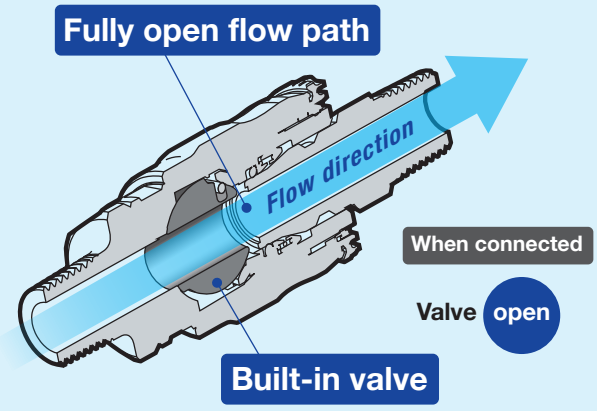
Quick connect coupling for air piping | FULL BLOW CUPLA

Special website

**Up to approximately 40% higher flow rate with low pressure loss*
For improved work environments**

*Compared with HI CUPLA

- Smooth connection and disconnection at zero internal pressure
- Valve can be opened and closed while connected



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