Technology Focus

Murata Catches up as Demand for Fuel Cell Systems Grows

Fuel cell systems, which are expected to act as the next-generation power supply, generally require several kinds of auxiliary equipment. By now, high-quality fuel auxiliary equipment is being supplied for fixed-installation systems, such as home-use fuel cells. On the other hand, there is a high expectation for fuel cells as the next-generation power supply for small-sized mobile equipment with fast-expanding performances.

For this reason, various manufacturers are stepping up their efforts to develop small-sized fuel cell systems. So far, there has not been enough market distribution of auxiliary equipment that complies with these small-sized fuel systems.

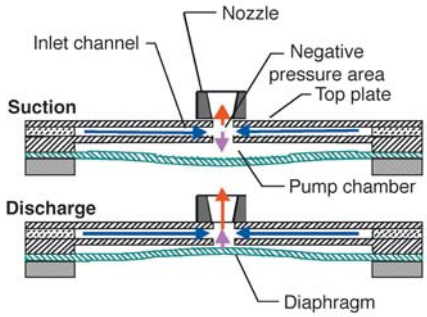

Fig.1: Micro-blower structure

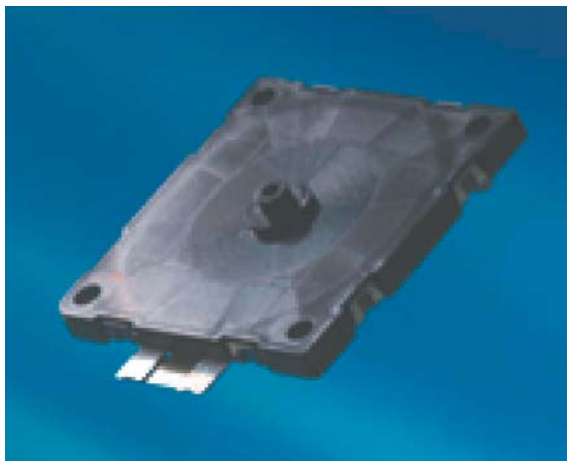

Photo 1: Micro-blower external appearance

Based on New Principles

The Direct Methanol Fuel Cell (DMFC) is expected to become mainstream for small-sized fuel cell systems. Most likely, the main auxiliary equipment required in this case is the fuel supply pump for supplying methanol to the anode electrode and the air supply blower (or pump) for supplying air to the cathode electrode. Among the auxiliary equipment, fuel supply pumps that have the potential to withstand practical application have been introduced. At present, however, there are no air supply blowers in the market that can withstand practical application.

Murata Manufacturing Co., Ltd. has developed a micro-blower, which is an air blower device and a fluid device micro-pump, designed on a completely new principle. These new products were developed by combining an extremely thin actuator, which uses piezoelectric ceramics previously applied to sound components, and a newly invented fluid rectifier flow path structure. The operating principle of this micro-blower is completely different from conventional blowers. It has very interesting properties such as low power consumption and vibration-free, in addition to small size, low profile, and high-pressure generation capacity. This article introduces the structure and characteristics of the micro-blower and discusses relevant information about the micro-pump.

Suits Small Fuel Cells

Murata has developed a micro-blower for air supply to the cathode electrodes of fuel cell systems that can be installed in smaller mobile devices. This micro-blower uses a completely different principle from conventional blowers to achieve airflow. Although the flow rate is rather small, it offers features such as small size, low profile, and high-pressure generation capacity. The micro-blower is also equipped with features such as low power consumption and no vibration. Murata believes that this product will serve as a most suitable air-blower for small-sized fuel cells to be installed in the future in small-sized mobile equipment, such as mobile phones.

Fig. 1 shows the structure and principle of this new micro-blower. When the diaphragm, which is constructed by affixing a disc-shaped piezoelectric element on a metal diaphragm, vibrates at approximately 26kHz, there is repeated air suction and discharge from a single ventilation opening provided in the pump chamber. Air sucked into the pump chamber from the inlet channel during the suction operation passes through a nozzle on the top plate, which is placed on the same

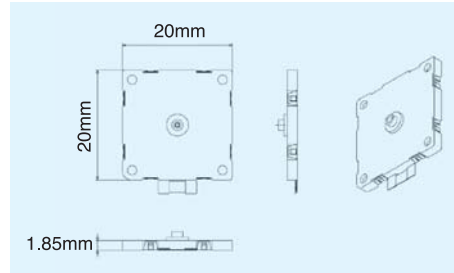

Fig.2: Micro-blower's outside dimensions

Table 1: Micro-blower specifications

Item	Specifications
Maximum flow rate	1.0 L/min
Maximum static pressure	2.0 kPa
Operating frequency	26 kHz (*1)
Driving voltage	5.3 Vac (*2)
Power consumption	0.18 W (*3)
Weight	1.5G
Size	20 × 20 × 1.85mm (*4)

**1 Nominal value, same as the resonance frequency.*
**2 Approximately 15Vpp of sine wave or rectangular wave.*
**3 Nominal value during AC 5.3V drive.*
**4 Excluding portions that protrude.*

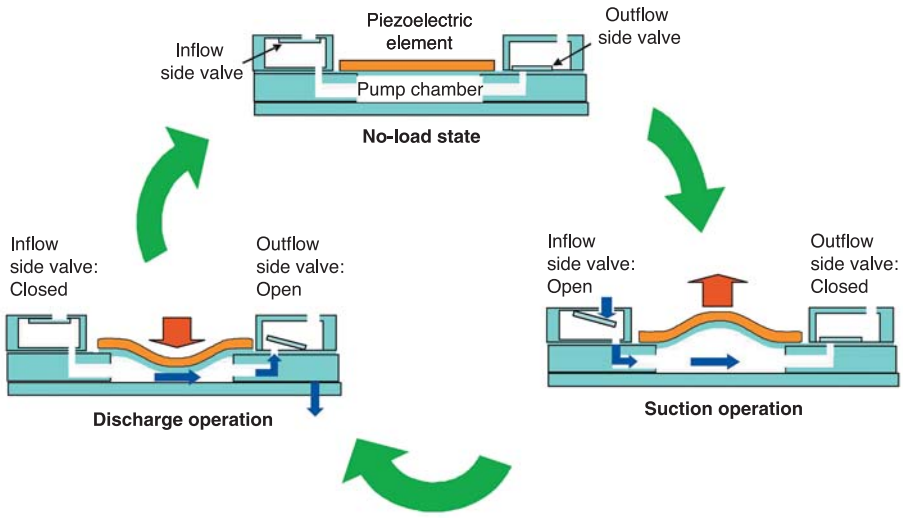

Fig. 3: Micro-pump structure and principle of operation

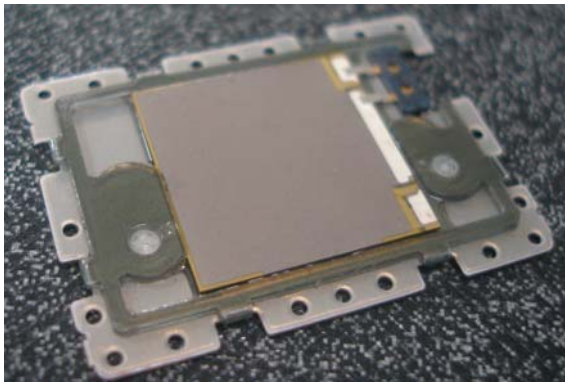

Photo 2: Micro-pump external appearance

axis as the ventilation opening during the discharge operation. The air expands in a tapered tube and is then discharged. When the air is discharged, an area of negative pressure is produced in the space between the ventilation opening and nozzle through the Venturi effect. Because of the negative pressure that is produced, the air in inlet channel is sucked continuously. The continuous pump operation from the inlet channel to nozzle is achieved in this manner.

As described above, the micro-blower produces airflow by the vibrations of a metal diaphragm affixed with a piezoelectric element. Therefore, it does not have a rotary mechanism like the conventional blower fans and scroll blowers, which makes it possible to design a small and low profile micro-blower that has almost no vibration. Essentially, it produces ultrasonic vibration at approximately 26kHz, which is the driving frequency.

Furthermore, the piezoelectric element of this micro-blower is basically a voltage-driven device and features low power consumption. Photo 1 shows the external appearance of the micro-blower designed and manufactured by Murata and Fig. 2 shows its outside dimensions.

Durability is frequently a problem for auxiliary equipment used for fuel cells. This micro-blower, however, incorporates no rotary or sliding parts so there is no wear. For this reason, it has longer life.

Provides Ample Fluid-Flow

Below provides the detail on the fluid-flow micro-pump. This micro-pump also uses piezoelectric ceramics as its driving source, as in the case with the micro-blower.

The specifications expected in the micro-pump are as follows:

(1) Ultra-small size and low profile
(2) High fluid discharge pressure
(3) Lower power consumption
(4) Suction force from a non fluid-tight state

This time, Murata has successfully developed a micro-pump that can provide an adequate fluid-flow operation by combining the following technologies of the company:

- The company's original piezoelectric element technology that features large displacement and high rigidity characteristics;
- Mechanical design technology that realizes high rigidity and low profile package;
- Precision-machining and fluid simulation technologies and other technologies.

Fig. 3 shows the cross-sectional structure of the micro-pump and its principle of operation.

When the piezoelectric element is displaced upward, the volume in the pump chamber expands and the inner pressure in the pump chamber drops. As a result, air pressure is applied on the inflow side valve and it opens, causing air and fluid to flow into the pump chamber. Next, the piezoelectric element is displaced downward and reduces the volume in pump chamber, causing the inner pressure in the pump chamber to increase. Consequently, air and fluid flow out from the pump chamber. The air and fluid flow is achieved by repeating this operation. Photo 2 shows the external appearance of the micro-pump designed and manufactured by Murata.

Table 2 indicates the main specifications of this micro-pump.

Table 2: Micro-pump specifications

Product size	24 × 33 × 1.325mm
Driving voltage	±6V
Fluid discharge flow rate	1μL/s (min.)
Fluid discharge pressure	35kPa (min.)
Air suction pressure	6kPa (min.)

Note: The above specification values of the fluid discharge flow rate, air suction pressure, and fluid discharge pressure indicate the micro-pump performance during a 1Hz driving frequency. Micro-pump uses Methanol as its fluid.

Conclusion

Murata leverages on its small, low-profile, and low-power consumption micro-blower and micro-pump. The company hopes to play a vital role in the advancement of the small fuel cell market by commercializing these unique devices.

Murata intends to continue the developments of small mechatronics devices that can contribute to the development of miniaturized and lower power consumption equipment in various fields.

About This Article:

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