Fuel Cell Market

Mass flow and pressure measurement and control

Foto: Vito NV

Foto: MAN Nutzfahrzeuge AG

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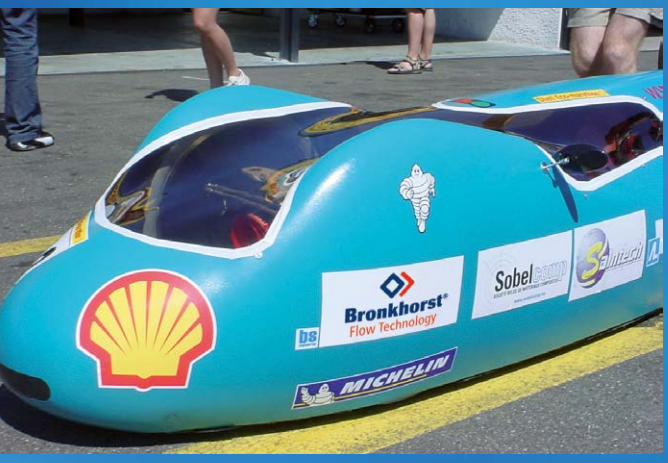
Bronkhorst®

An introduction to Bronkhorst®

Bronkhorst High-Tech BV, the European leader in Thermal Mass Flow Meters / Controllers and Electronic Pressure Controllers, has over 35 years experience in designing and manufacturing precise and reliable measurement and control devices. With the widest range of instruments available on the market Bronkhorst® offers innovative solutions for many different applications across a great many different markets. Our instruments are manufactured to customer specifications with models that are suitable for use in Laboratory, Industrial and Hazardous Area environments. In addition, the company provides tailor-made, complete fluid control solutions for O.E.M. systems.

Bronkhorst® has a wealth of knowledge and an enviable world-wide reputation within the fuel cell market. In this leaflet we will illustrate that by presenting some typical applications.

Applications in the fuel cell market

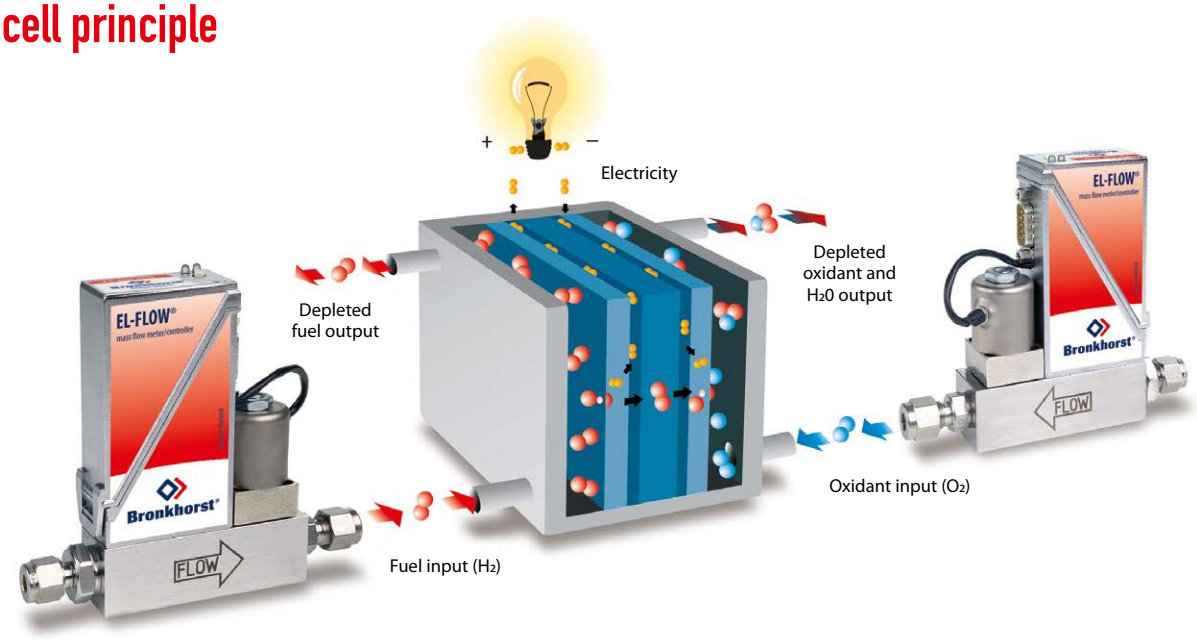


Fuel cell driven car at Eco-marathon with Bronkhorst mass flow meter.

Bronkhorst® offers:

- precise and fast Mass Flow Controllers for gases, e.g. for the control of Hydrogen and Oxygen **in PEM fuel cell testbeds, verification of catalysts** and accurate and repeatable **gas mixture generation**.
- accurate and compact Mass Flow Controllers for liquids, e.g. for **feeding Methanol to a DMFC (Direct Methanol Fuel Cell)**.
- Coriolis type mass flow meters for precise and fast **measurement of reactant or exhaust gas flow**, independent of gas composition or humidity.
- flexible and accurate **humidification of the air supply to a fuel stack**, using a CEM evaporation system, e.g. in **Solid Oxide Fuel Cells (SOFC)**.
- precise and reliable electronic (differential) pressure controllers, e.g. **for stabilizing the pressure in the fuel cell against change of flow rate** and **maintaining a constant pressure difference across the membrane**.

Fuel cell principle



Mass flow meters / controllers for gases

Bronkhorst® Mass Flow Meters / Controllers are available in the widest range offered on the market for flows from 0...1 ml_n/min up to 0...400 m^3_n/h and from low operating pressures (vacuum) up to 700 bar. Bronkhorst Mass Flow Controllers excel in stability, maintainability and quality.

For Fuel Cell applications, where MFC's are used for the **control of gases such as Oxygen, Hydrogen, Air and Carbon Dioxide**, two different product series should be distinguished: The EL-FLOW series with regular laboratory style housing and the IN-FLOW series with industrial IP65 protection. Both series are available with analog and digital in- / outputs. The instruments have a basic pc-board, containing all of the general functions needed for measurement and control. It has analog I/O-signals and also an RS-232 connection as a standard feature. In addition to this there is the possibility of integrating an interface board with DeviceNet™, PROFIBUS DP, Modbus, EtherCAT® , or FLOW-BUS protocol.

Mass Flow Controller for gases with IP65 housing

Mass flow meters/ controllers for liquids

Bronkhorst® offers Mass Flow Meters and Controllers for liquids in ranges between 0...30 mg/h and 0...20 kg/h (water equivalent). LIQUI-FLOW™ flow meters are compact instruments, only requiring a small differential pressure. Furthermore LIQUI-FLOW™ features:

- fast and accurate measuring signal;
- insensitivity to mounting position;
- very small internal volume.

In accordance with the Mass Flow Controllers for gases, LIQUI-FLOW™ instruments are available with analog (0...5/10 Vdc or 0/4...20 mA) and digital (RS-232) communication, with optional on-board fieldbus interface. Flow control is achieved by integrating a control valve onto the body of the liquid flow meter. This control valve has a purge connection that enables easy elimination of air or gas when starting up the system. LIQUI-FLOW™ is used in Fuel Cell applications for **humidification of process gases** and for **dosage of liquid Methanol**. For subsequent evaporation of water or methanol Bronkhorst® offers the CEM-system, described on the following page.

Digital Liquid Flow Controller/Meter

Coriolis mass flow meters / controllers for liquids and gases

Bronkhorst® offers a series of instruments providing highest accuracy of mass flow metering for liquids and gases. (mini) CORI-FLOW™ utilises patented , advanced Coriolis type mass flow sensors to achieve unsurpassed performance, even with changing operating conditions in pressure, temperature, density, conductivity and viscosity. The devices are offered with or without integral control valve and analog and digital communication. The electronic control function forms part of the normal circuitry in the flow meter. The instruments can be offered in ranges from 20 g/h up to 600 kg/h (full-scale values). The maximum operating pressure for the instruments is 100 bar and they can be used from 0 up to 70°C, or even 120°C with remote electronics.

Coriolis type Mass Flow Meters are, amongst others, selected for **testing cell stack systems** because of their fast response and their exact mass flow measurement regardless of (humidified) reactant or exhaust gas composition.

Coriolis Mass Flow instruments

Electronic pressure controllers

The EL-PRESS Series Electronic Pressure Meters and Controllers have a well-proven compact thru-flow design and are available in pressure ranges from 100 mbar up to 400 bar. The Pressure Controller performs with high accuracy and repeatability; it must be specified for forward pressure control (P-600 series) or backward pressure control (P-700 series).

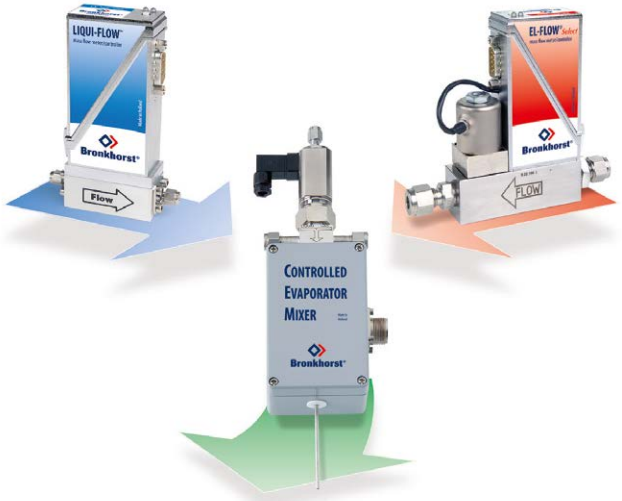
The EL-PRESS Electronic Pressure Controllers are compact devices, constituting an integrated pressure transducer and control valve for Kv-values up to 6,6 x 10^{-2}. For higher flows we recommend to use a separate P-500 pressure transducer, preferably to be mounted outside the flow stream to eliminate frictional losses, and a special, patented Bronkhorst® control valve for Kv-values up to 6,0. For applications where low differential pressure is combined with a high flow a belows operated valve (series F-004) can be used.
In Fuel Cell systems Electronic Pressure Controllers are used to **stabilize the pressure against change of flow rate** and **maintaining a constant pressure difference across the membrane**.

Electronic Pressure Controller with fieldbus interface

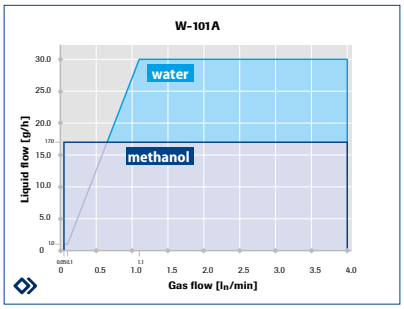
Evaporation systems

Bronkhorst have developed a unique patented system to realise Mass Flow Control of Vapours: the CEM-system. 'CEM' stands for Controlled Evaporation and Mixing. In Fuel Cell applications the CEM-system is a reliable and flexible means of **humidification of the process gas (Air, CO_2, …)** . In other applications **liquid Methanol is evaporated before entering the Fuel Cells**.

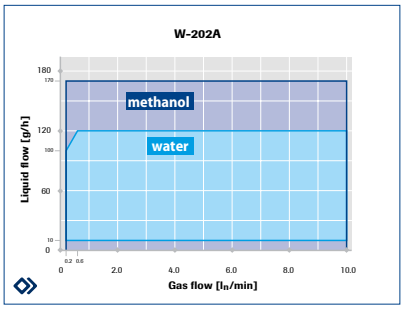
The CEM-system is built up from a Mass Flow Meter for liquid, a Mass Flow Controller for the carrier gas and a mixing chamber in which a liquid flow is injected in the carrier gas flow. Subsequently the mixture is led into a temperature-controlled heating device, which results in complete evaporation. The system is completed by a Power Supply Readout Unit with flow indication and set-point facility.
This way of vapour source control is very accurate, reliable and fast, because the amount of liquid and gas is measured and controlled using thermal Mass Flow Controllers. The system can be applied for atmospheric as well as pressurized systems. There are three series (10, 100 and 1000 Watt), covering liquid ranges up to 1200 gram per hour of water or 1700 gram per hour of Methanol. The diagrams on this page show the liquid and gas capacities for each series.



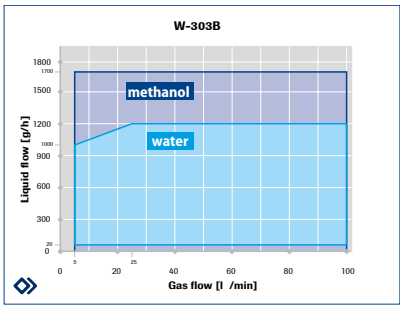
Components of the CEM-System



Capacities of the 10 Watt CEM-system, models W-101A/W102A



Capacities of the 100 Watt CEM-system, model W-202A



Capacities of the 1000 Watt CEM-system, model W-303B

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