CEM and VDM

Solutions for Vapour Flow Control

Bronkhorst®

Introduction

Bronkhorst High-Tech B.V. has many years of experience supplying mass flow control solutions for many different applications within such markets as semiconductor, chemical and solar industries. Our instruments are made to a customers' specification, in whichever style is suitable, for laboratory, industrial systems or OEM installations. Bronkhorst® thermal mass flow meters/controllers are used for accurate, repeatable control of inert gases as well as handling reactive gases, covering flow rates from 0,7 ml_n/min up to 10.000 m^3_n/h (Full Scale values). Bronkhorst offers liquid flow meters/controllers for small flow ranges, from 5 mg/h up to 1000 g/h based on thermal mass flow sensors and from 50 mg/h up to 600 kg/h using Coriolis mass flow sensors.

Vapour Flow Control

Our unique and patented 'CEM' technology, which stands for Controlled Evaporation Mixing, is developed for accurate vapour flow control. Traditional bubbler systems are often not capable of handling sufficient quantities of liquid with a low vapour pressure, or perform in an imperfect way. Moreover, they cannot instantaneously provide vapour of a mixture of liquids with different vapour pressures. These issues are overcome with our vapour delivery solutions. Bronkhorst's evaporation technology is fast, accurate, highly repeatable and efficient.

CEM-Technology: Controlled Evaporation and Mixing

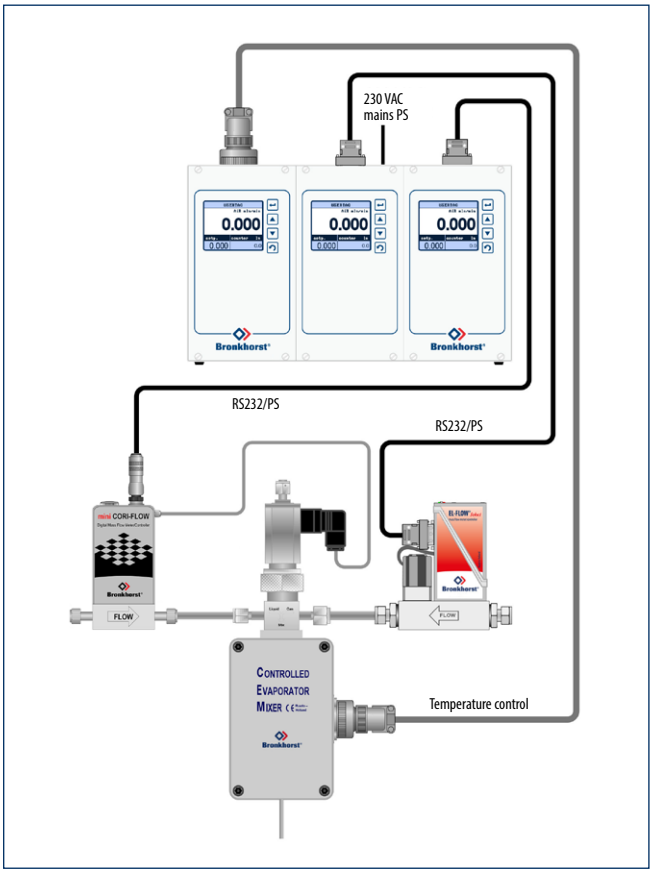
The CEM-System is an innovative Liquid Delivery System (LDS) that can be applied for atmospheric or vacuum processes. The vapour generation system consists of a (thermal or Coriolis) liquid flow controller, a gas mass flow controller (MFC) for carrier gas and a temperature controlled mixing and evaporation device. The system is suitable for mixing liquid flows of 1-1200 g/h resulting in saturated vapour flows of 50 ml_n/min up to 100 l_n/min. This vaporiser system can replace bubblers. New opportunities created with the CEM-system: mixtures can be evaporated and even solids, dissolved in solvents can be vaporised successfully.

Features

- accurately controlled gas/liquid mixture
- fast response
- high reproduceability
- very stable vapour flow
- flexible selection of gas/liquid ratio
- handles water, solvents and mixtures
- lower working temperature than conventional systems
- optional control by PC/PLC (RS232/fieldbus)

Components of a CEM-system

A complete CEM system incorporates a carrier gas flow controller, a liquid flow meter, a 3-way mixing valve in which the liquid is injected into the carrier gas stream, a heat exchanger in which total evaporation is achieved, and a readout/control unit including power supply, for operation of the gas flow, liquid flow and temperature.



Note: For a description of our gas and liquid flow meters/controllers and our E-8000 Readout/Control units please see the relevant brochures for these items.

Model number identification CEM Series

CEM model	Description	Max. capacity approx.*	
W-101A-9N0-K	10 W (for µ-FLOW)	2 g/h liquid	4 l_n/min gas
W-102A-NN0-K	10 W	30 g/h liquid	4 l_n/min gas
W-202A-NN0-K	100 W	120 g/h liquid	10 l_n/min gas
W-303B-NN0-K	1000 W	1200 g/h liquid	100 l_n/min gas

** depends on liquid and process pressure; table based on water at 1 atmosphere. For other liquids or pressure conditions apply to factory.*

Connections
Inlet liquid
Inlet gas
Outlet mixture

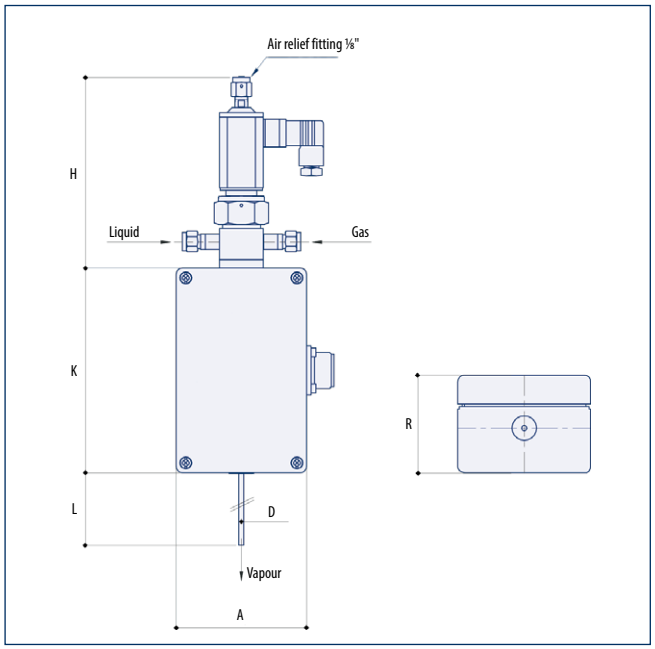
Operating limits	
Max. pressure	100 bar
Max. heater temperature	200°C

0	None
1	⅛" OD compression type
2	¼" OD compression type
3	6 mm OD compression type
7	¼" Face Seal female
8	¼" Face Seal male
9	Other

Optional

- Separate control valves for mixing gas and liquid.
- Separate heat exchanger.

Dimensions 3-way Mixing Valve and Heat Exchanger

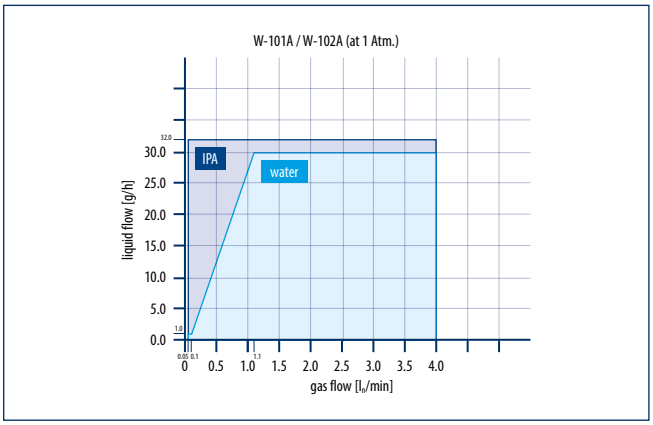


CEM model	A	D	H	K	L	R	Weight (kg)
W-101A/W-102A/W-202A	80	⅛"	120	125	70	60	1,7
W-303B	180	¼"	169	280	50	103	9,3

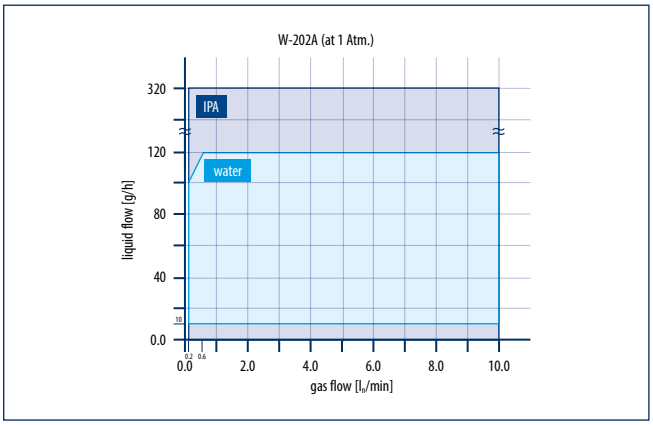
Dimensions in mm. All dimensions are subject to change without notice.
Certified drawings are available on request.

W-202A and W-303B Mixing Valve with Heat Exchanger

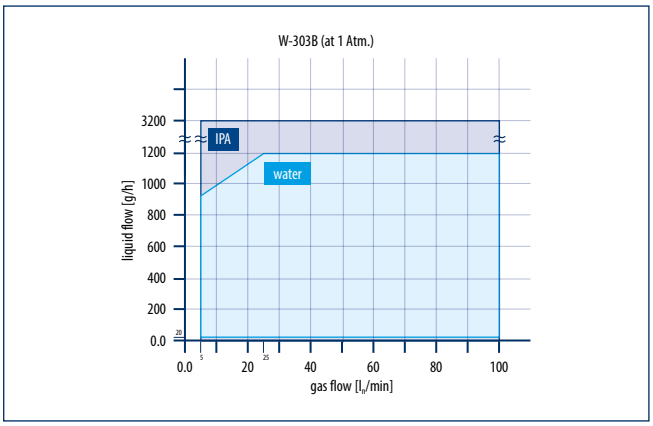
Capacities



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

All-In-One Vapour Delivery Modules – VDM Series

VDM Series: Vapour Delivery Modules

Based on the CEM-technology as described in the previous section, we designed a series of Vapour Delivery Modules. These compact sub-systems incorporate the components of the CEM-System and more! Besides gas and liquid flow controllers and the temperature controlled evaporator, the VDM Series feature integrated power supply with display (1.8" TFT) and control functions. As an option, the unit offers local or remote trace heating temperature control to prevent condensation of the outgoing vapour flow. The compact, 'plug and work' module can generate (saturated) vapour flows within the range of 100 ml_n/min up to 10 l_n/min. It can be applied for atmospheric or vacuum processes and is capable of evaporating mixtures and even solids, dissolved in solvents.

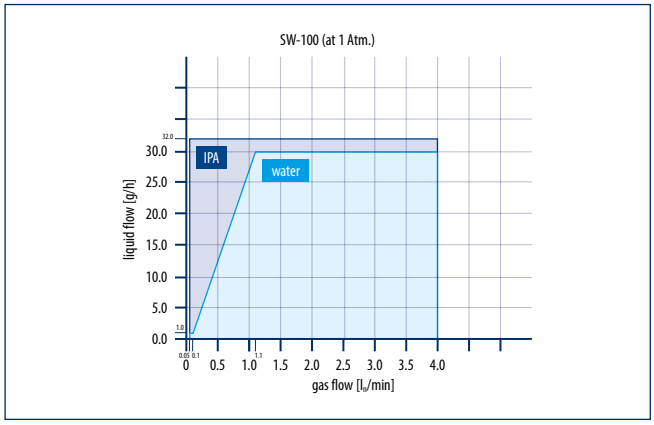
Additional features (compared to separate CEM system components)

- Less engineering time for the customer
- Pre-tested, safe and ready to use
- Readout/Control panel, incl. 1,8" TFT display, alarm/signalling and counter functions.
- Integrated fieldbus interface (option)

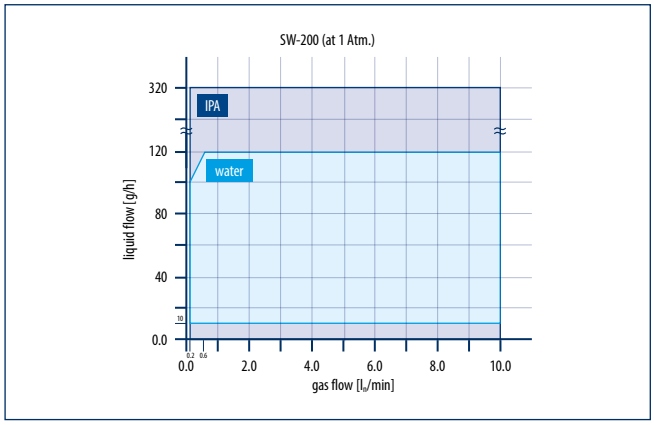
Options

- Dual carrier gas supply
- Dilution gas supply
- Trace heating temperature control incl. status indication

Capacities



Capacities of the 10 Watt VDM-module, model SW-100



Capacities of the 100 Watt VDM-module, model SW-200

Model number identification VDM Series

SW - N 0 N - N - N N - A - N N - A

Code Heater size

1	W-100* (¼"OD MFC and ⅛"OD LFM outlet) - 10W
2	W-200* (¼"OD MFC and ⅛"OD LFM outlet) - 100W

**factory selected internal gas and liquid supply outlets*

Mix valve

0	Factory selected (standard)

Gas and liquid supply

0	Carrier gas and liquid flow supply
1	Dual carrier gas and liquid flow supply
2	Carrier gas, liquid flow and dilution gas supply
3	Dual carrier gas, liquis flow and dilution gas supply

Mains power supply

3	220…240 Vac
5	110…120 Vac

Tracing control

0	None
1	Additional tracing control

External communication

A	RS232 communication
R	FLOW-BUS
Z	Other communication (to be specified)

Mix outlet

0	None: ⅛" tube for SW-10n- and SW-20n
1	⅛" OD compression type
3	6 mm OD compression type
8	¼" face seal male
9	Other connection (to be specified)

Purge outlet

1	⅛" OD compression type
9	Other connection (to be specified)

Plunger seat

K	Kalrez® (FFKM)

Technical specifications

Measurement / control system

Gas flow range (inlet)	0,05…10 l_n/min carrier gas*
Liquid flow range (inlet)	0…120 g/h water, precursor fluid, etc.*
Vapour flow (outlet)	0,05…10 l_n/min*
Inlet pressure	up to 10 barg*
Outlet pressure	vacuum…5 barg*
Ambient temperature	5…40 °C
Max. heater temperature	200 °C

** order specific*

Mechanical parts

Gas inlet	⅛", ¼" or 6 mm OD compr. type or ¼" face seal male
Liquid inlet	⅛", ¼" or 6 mm OD compr. type or ¼" face seal male
Vapor outlet connection	⅛" tube (other on request)
Purge outlet	⅛" OD compression type or ⅛" face seal male
Wetted materials	SS316, Viton/Kalrez (FFKM) seals, Kalrez (FFKM) plungers

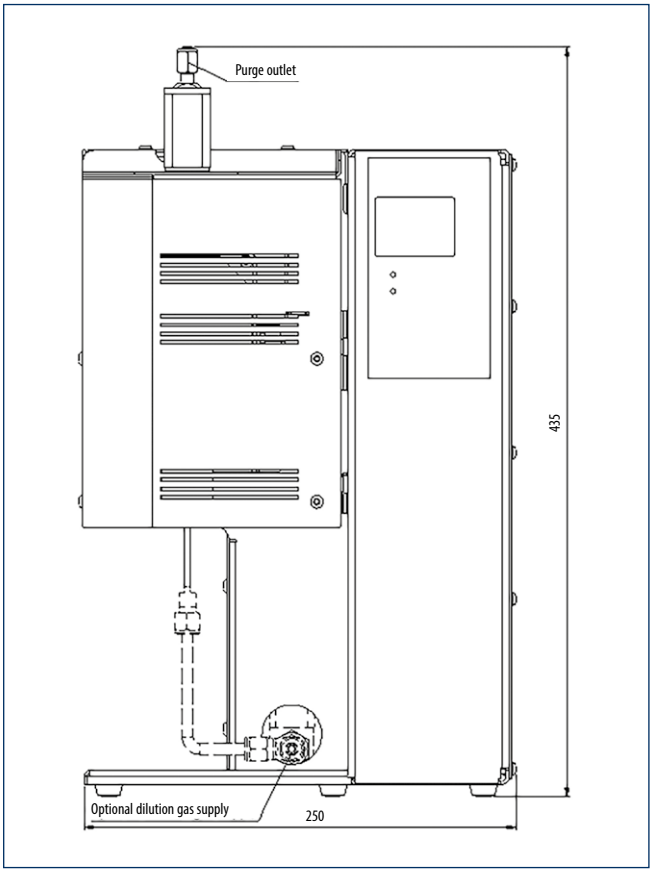
Electrical properties

Display	1.8" (TFT technology)
Mains supply inlet	IEC 60320-1/C20 male socket with on/off switch, 230V / 115V; 50Hz / 60Hz
Power consumption	max. 250 VA; add 300 VA for optional tracing control
Electrical connection	FLOW-BUS (2 x RJ45 connector) or RS232 (1 x 9-pin sub-D connector) Optional: Pt100-connection (1 x 4-pin M12 male, a-coded) Optional: IEC 60320-2-2/C13 female tracing outlet

Note: For gas and liquid flow control the VDM modules are equipped with Thermal or Coriolis Mass Flow Meters/Controllers or a combination of these devices.

Technical specifications and dimensions subject to change without notice.

Dimensions



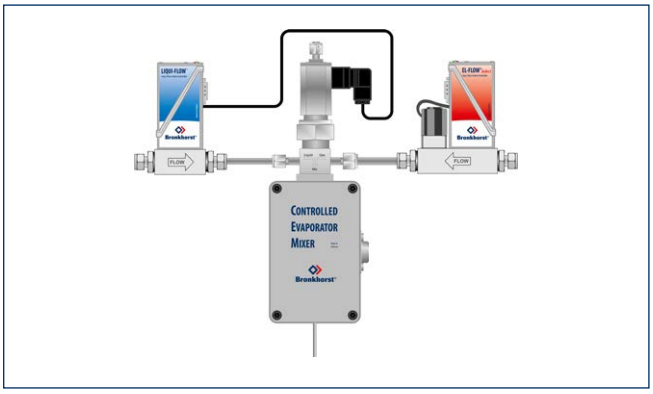
Note: Please consult the VDM-pages on our website for a complete set of dimensional drawings.

Module configurations

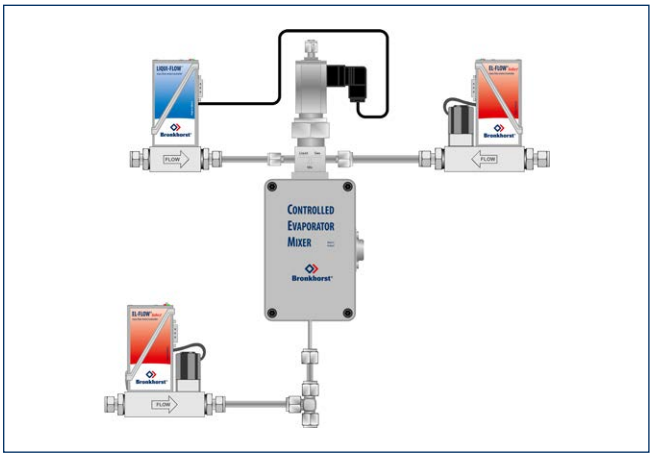
The VDM-Series Modules are greatly standardised. Bronkhorst offers the following configuration options:

- Single carrier gas supply, no dilution (standard)
- Dual carrier gas supply, no dilution
- Single carrier gas supply with dilution
- Dual carrier gas with dilution
- Thermal or Coriolis Mass Flow Meter for liquid flow control

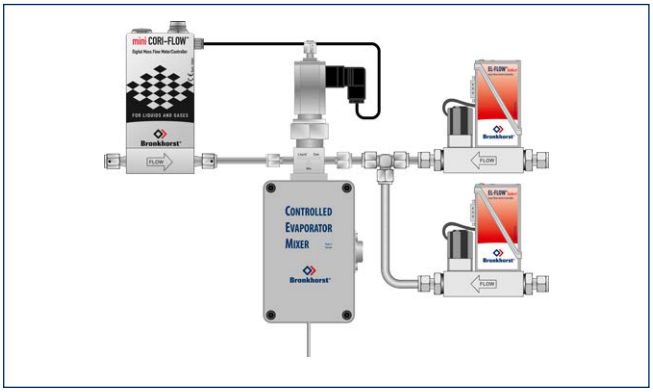
Illustration showing the internal mounting position of the liquid flow meter and the MFC for the carrier gas



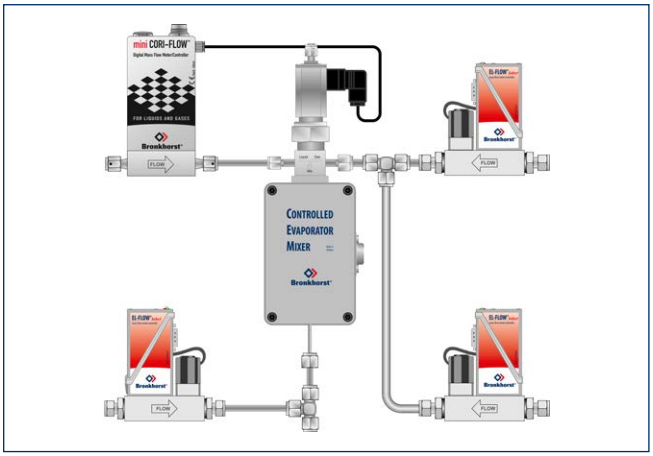
Single carrier gas supply, no dilution, thermal liquid flow meter.



Single carrier gas supply with dilution, thermal liquid flow meter



Dual carrier gas supply, no dilution, Coriolis liquid flow meter



Dual carrier gas supply with dilution, Coriolis liquid flow meter

Applications

Our CEM and VDM systems have successfully been applied in a large number of different applications in wide variety of markets. For example, tools (drills, screwdrivers, saw blades, etc.) and machine parts are coated to improve their wear resistance, electric and dielectric (insulating) layers are deposited in semiconductor and solar cell manufacturing processes, the heat insulation of glazing is improved by a coating applied to its surface and the humidity in reactor/process chambers is controlled to ensure optimum performance.

CVD (Chemical Vapour Deposition)

Chemical Vapour Deposition (CVD) is a chemical process used to produce high-purity, high-performance solid materials. The process is not only used in the semiconductor industry to produce thin films for LEDs, transistors and DRAMs, but also in surface treatment, hardening processes and manufacturing of high temperature superconductors. In a typical CVD process, the surface (wafer or substrate) is exposed to one or more volatile precursors, which react and/or decompose on the substrate surface to produce the desired deposit.

Bronkhorst's vapour flow control solutions are used in various types of CVD processes. For example:

- ALD (Atomic Layer Deposition) or ALCVD (Atomic Layer CVD): deposits successive layers of different substances to produce layered, crystalline films.
- APCVD (Atmospheric pressure CVD): CVD processes at atmospheric pressure.
- MOCVD (Metal Organic CVD) - CVD processes based on metalorganic precursors.
- PECVD (Plasma-Enhanced CVD): CVD processes that utilise a plasma to enhance chemical reaction rates of the precursors.

Defined Humidification of Gases

The CEM-technology is ideally suited to the accurate adjustment of dew or moisture. The intrinsic characteristics of large dynamic range and high accuracy ensure that the moisture level can be controlled with great flexibility from only a few ppm up to virtually 100%, whilst also maintaining a very high stability in dew point. Full functionality is retained with operating pressures as high as 100 bar.

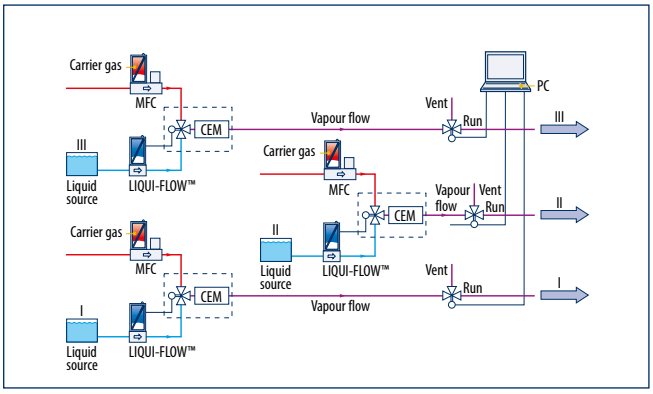
Calibration of Gas Chromatographs, Mass Spectrometers and Gas Sensors

Through the combination of Mass Flow Controllers for liquids and the CEM system, gas phase concentrations can be produced as desired.

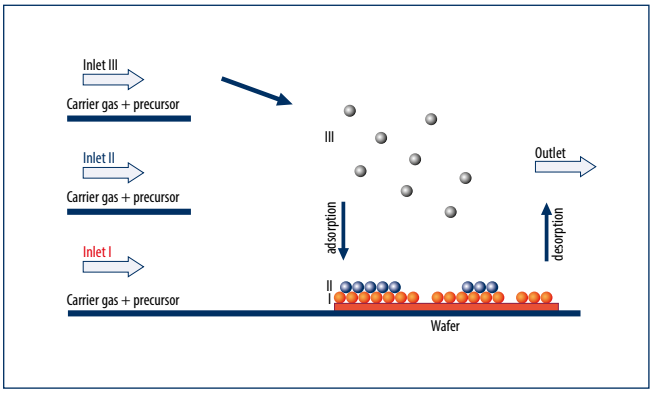
Thus Mass Spectrometers or Gas Chromatographs can be calibrated as the reference stream from the CEM is both highly reproducible and highly accurate due to the direct action of the Mass Flow Controllers.

Miscellaneous

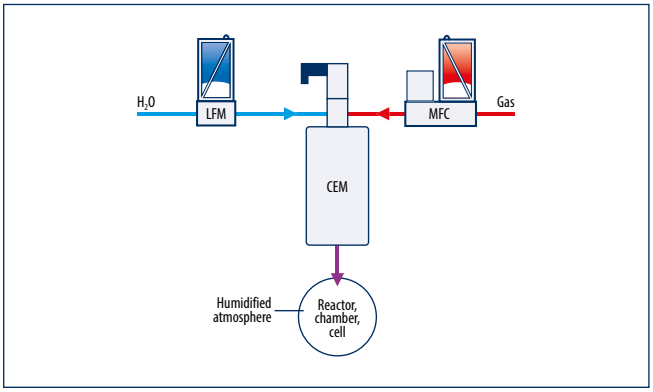
- analysers with reference gas vapour concentrations
- toxic gas effects on protective clothing
- analysers with reference H_2O vapour concentrations
- anaesthetics
- humidification of fuel cells
- crystal breeding installations
- dosage of additives, e.g. perfume, vitamins, etc.



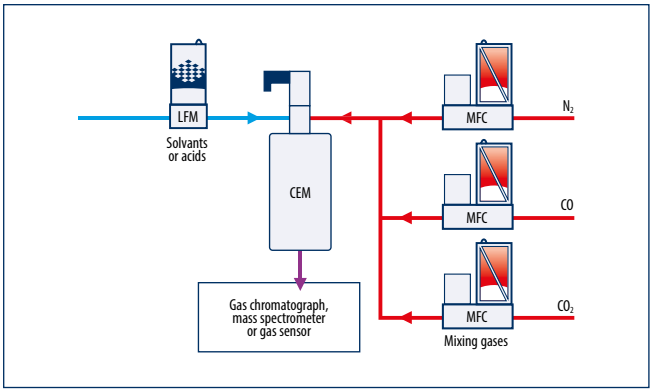
Example of a Direct Liquid Injection (DLI) System for ALD Processes



Schematic representation of an ALD process



Defined humidification



Calibration of chromatographs

Bronkhorst®

Bronkhorst High-Tech designs and manufactures innovative instruments and subsystems for low-flow measurement and control for use in laboratories, machinery and industry. Driven by a strong sense of sustainability and with many years of experience, we offer an extensive range of (mass) flow meters and controllers for gases and liquids, based on thermal, Coriolis and ultrasonic measuring principles. Our global sales and service network provides local support in more than 40 countries. Discover Bronkhorst®!

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