

## Controlled Evaporation and Mixing

### **Gas and vapour ratio control to create precise atmospheres and process conditions.**

Bronkhorst have been supplying their tried and tested Controlled Evaporator Mixer (CEM) System for many years however recent innovations have further extended their capability and areas of use. Wherever an atmosphere needs to be closely controlled with two or more constituents, the CEM can be used to create this humid/vapour condition both accurately and repeatedly.

Traditionally, a liquid vapour within a carrier gas has been generated by using a Bubbler Systems although more recently vapour Source Controllers have been used. Commonly, however, neither of these solutions can handle sufficient quantities of liquid with a low vapour pressure such that their performance rapidly deteriorates. Moreover, they cannot instantaneously provide vapour of a mixture of liquids with different vapour pressures.

Bronkhorst High-Tech B.V. have therefore developed a unique patented system to realise Mass Flow Control of Vapour: the CEM-Liquid Delivery System (LDS). It can be applied to atmospheric, pressurized and vacuum processes.



### **Typical Applications:**

Our applications are extremely varied, spanning virtually every industry sector, with our customers regularly finding even more new and innovative ways to benefit from the technology. Common applications include Fuel Cell humidity control, reactor chamber atmosphere control through to Chemical Vapour Deposition. Markets include the coating of solar cells and glass panels to improve their electrical and thermal properties, to the surface coating of tools for improved wear performance and the optimization of humidified synthetic breath for the pharmaceutical and medical research markets. With an accurately controlled ratio of gases (where more than one gas type is used) and a precisely controlled injection rate of a liquid source it is possible to calibrate other scientific instruments such as Gas Chromatographs, Mass Spectrometers and other gas sensors.

**Description:**

At room temperature the liquid is drawn from a container (with an inert gas blanket or membrane) and measured by a liquid flow meter. The required flow rate is controlled to the setpoint value by a control valve forming an integral part of the patented liquid flow and carrier gas mixing valve. The gas is applied to the mixing chamber from a Gas Controller accurately supplying the required gas to be mixed with the liquid. This mixture is then directed to the heating module of the system where the mixed gas and liquid are vapourised with a controlled heating range from room temperature to 200 Deg C. A complete system also incorporates a readout/control unit, including power supply, for operation of the CEM-system devices.

**Features:**

- accurately controlled gas/liquid mixture
- fast response
- high reproducibility
- very stable Vapour flow
- flexible selection of gas/liquid ratio
- lower working temperature than conventional systems
- optional control by PC/PLC (RS232/fieldbus)

**Liquids that are often used: (a selection of some references)**

• ETOH • SnCl<sub>4</sub> • TiCl<sub>4</sub> • HMDSO • TCA • TMB • HMDSn • TEOS • Water • SiHCl<sub>3</sub> • TIBA • Zn(C<sub>2</sub>H<sub>5</sub>)<sub>2</sub> • SiH<sub>3</sub>Cl • Cupraselect™ • Organic compounds (such as Acetone, Alcohol, Butanol, Ethanol, Hexane, Methanol, etc.)

**Specifications:**

The set-up of a CEM-system usually consists of 3 parts:

**1) EL-FLOW® Mass Flow Controller for Gases**

For measurement and control of the carrier gas flow. The amount of carrier gas required for the evaporation depends on the application (flow range, liquid, pressure, temperature).

**2) Coriolis Meters or LIQUI-FLOW™ Mass Flow Meter for Liquids**

For measurement of the liquid source flow.

**3) CEM 3-way Mixing Valve and Evaporator**

For control of the liquid source flow and mixing the liquid with the carrier gas flow resulting in total evaporation; complete with Temperature Controlled Heat-Exchanger to add heat to the mixture to realise complete vaporization. (Tmax 200°C / Pmax 100 bar).

### **VDM - Vapour Delivery Modules:**

One of the recent innovations is the concept of VDM™ - Vapour Delivery Modules – a bespoke design service whereby the components of the CEM system can be engineered into a tailor-made housing. This “plug-and-play” module could be a stand-alone laboratory instrument or could be designed to be close-coupled to other analytical instruments or equipment. Above all, the modules have been designed to be extremely easy to use, pre-tested safe and ready to use out of the box, multiple electronic interface options (including a safety handshake) and with a protective anti-catalytic (ceramic) coated evaporator. All the above instruments are available in varying capacities depending on the total output required.

