

# FLEC Air Control

*Installation operation and maintenance*

FL-1000 | Instruction manual | Version 2.0 | 11 September 2026



The FL-1000 supplies the FLEC Cell with filtered air at an adjustable flow and relative humidity. This manual explains how to connect, operate, check and maintain the air-control unit.

**Read the safety instructions** before connecting compressed air or removing any component. Verify delivered flow and humidity before starting a measurement.

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# Using this manual

Use this manual for the FL-1000 air-control unit with two manually adjusted air channels, a charcoal filter, glass humidifier and condenser. The front panel provides approximate flow indication; separate reference instruments are used to verify the delivered conditions.

The FLEC Cell, sampling pumps, sorbent tubes and analytical method have their own operating requirements. Select test conditions and acceptance criteria from the procedure used for the measurement.

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## Before the first measurement

- Identify the pressure regulator, all three selector valves and the humidifier connections.
- Check the clean-air supply, water, tubing and reference flow and humidity instruments.
- Keep sampling pumps stopped while diverting supply air for flow checks.
- Record the selected conditions and the verified values before collecting samples.

**Component references** such as 2.6 identify the numbered items in the front photograph. The rear photograph has a location guide. Left and right valve positions always mean as viewed from the front of the unit.

# Safety and pressure management

## **WARNING** Compressed air and glass components

Read this section before installation, cleaning or service. Never loosen a fitting, remove glassware or disconnect the filter while any part of the system remains pressurised. Handle the unit upright and support glass parts when releasing their clamps.

### **Keep an open air path**

Move each selector valve fully to its RUN or TEST position. Never leave a valve in the middle or vertical position: this blocks the air path and can cause pressure to rise, open the safety valve and, in some circumstances, break the humidifier.

Keep every active outlet unobstructed. Check tubing and reference instruments for restrictions. Never cap an outlet that is receiving flow or obstruct the safety-valve discharge.

### **Understand the three pressure values**

| Location                   | Meaning                                                                                                                                      |
|----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| External air supply        | Supply clean, dry air at 2-10 bar.                                                                                                           |
| FL-1000 pressure regulator | Adjustment range 0-7 bar. A typical working setting is 2 bar, with at least 0.5 bar between source pressure and the lower regulator setting. |
| Humidifier safety valve    | Opens if humidifier pressure exceeds 1 bar and reseals at 0 bar. This is a protective function, not an operating setpoint.                   |

**The front gauge** indicates pressure in the regulated filter section. It does not display the pressure in the glass humidifier.

**The rear-mounted regulator** shown on page 6 requires unit-specific setting instructions. Do not apply the front-regulator instructions to it.

### **If the safety valve opens**

Turn the FL-1000 pressure regulator down to zero immediately and isolate the external air supply. Stop sampling pumps. Allow the system to depressurise, then check selector positions and downstream restrictions. Inspect the glassware. Do not restart with damaged glassware or if the cause remains unresolved.

### **Before removing any component**

- 1. Stop sampling and isolate the source.** Close the external air-supply valve and reduce the FL-1000 regulator setting to zero.
- 2. Allow pressure to dissipate.** Keep an unobstructed flow path open; do not loosen a fitting to release pressure.
- 3. Confirm pressure release.** All pressure gauges must read zero and flow must have stopped. If pressure does not fall or trapped pressure is suspected, leave the assembly intact and contact CHEMATEC.

**Never open the charcoal-filter housing** or undo its top fitting. Remove the filter only as a complete assembly using the connections beneath the unit.

# Airflow through the unit

The FL-1000 requires an external source of clean, dry compressed air. Synthetic air is recommended. The activated-charcoal filter supports clean-air delivery, but does not make a contaminated source suitable for emission testing.

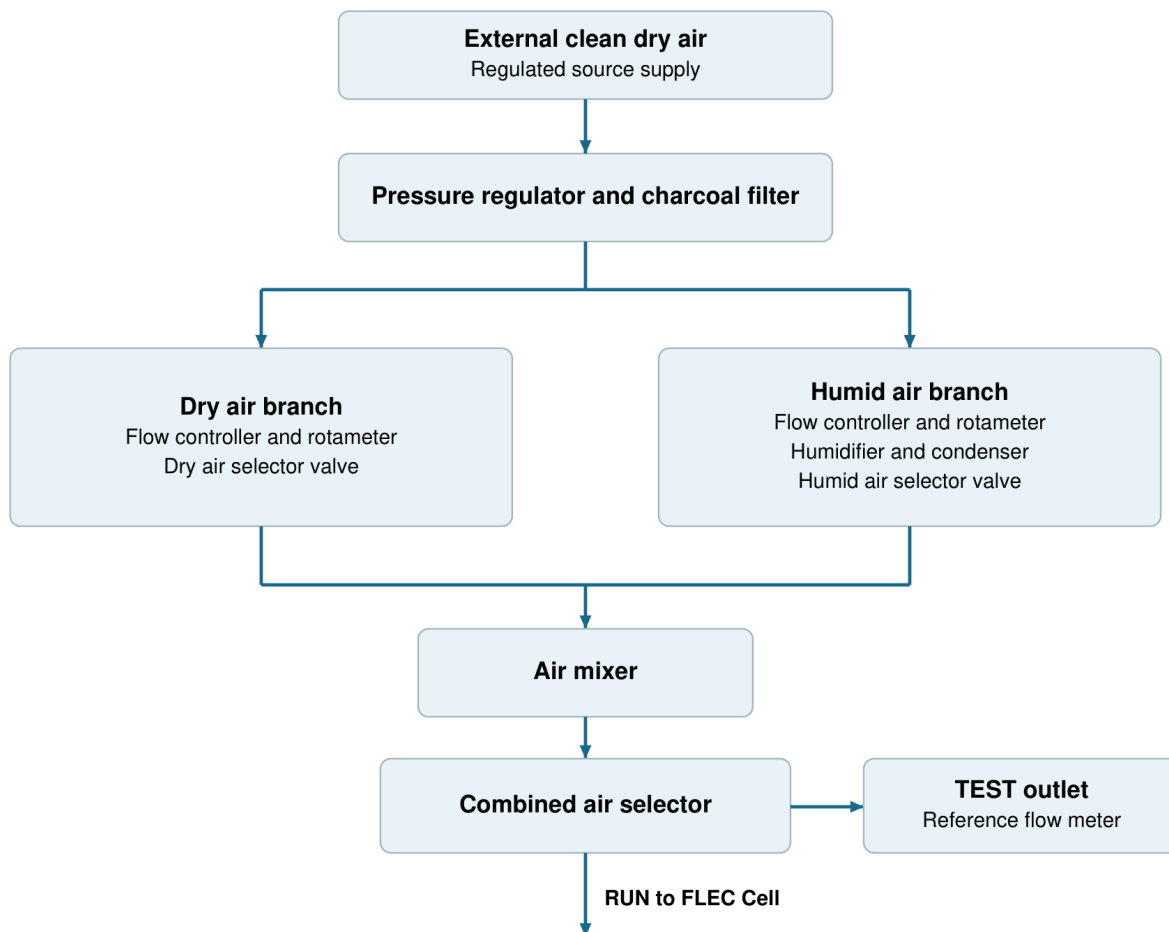


Figure 1. Functional airflow. Individual test outlets and service fittings are omitted.

## Dry and humid air are mixed

The dry channel and the humid channel are adjusted separately. Air passing through the humidifier takes up water vapour; the condenser limits liquid-water carryover. The mixer combines the streams before the air is supplied to the FLEC Cell.

The total delivered flow is the sum of the dry and humid flows. Their ratio provides an initial humidity setting. Actual relative humidity also depends on humidification performance and temperature, and must be checked at the delivered conditions.

## Reference measurements

Selector valves provide access to the individual channels and the mixed stream. The rotameters are guides for adjustment. Use a suitable calibrated reference flow meter for verification and a suitable humidity and temperature instrument to check the mixed air near the cell inlet.

# Front controls

The photograph identifies the operating controls and outlets. The humid channel is on the left and the dry channel on the right when facing the unit.

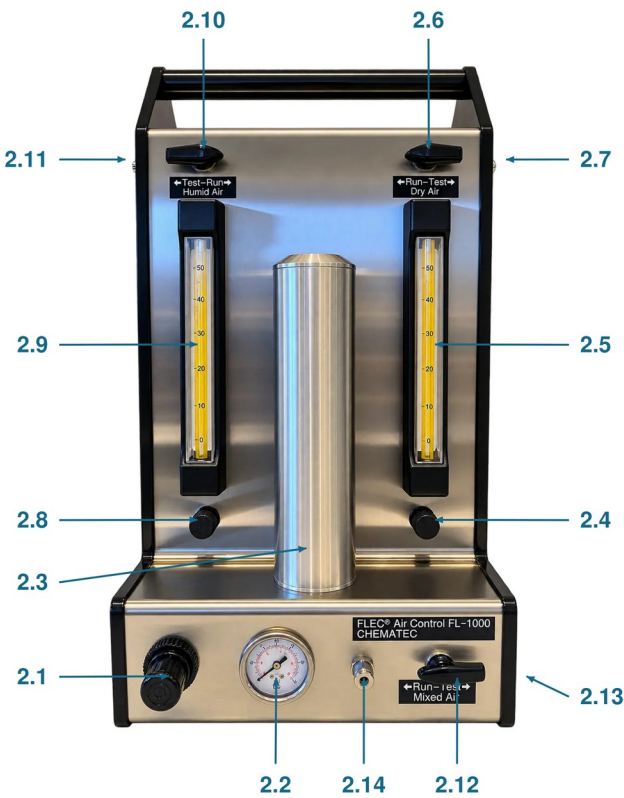


Figure 2. Front controls and component references.

| Ref | Component                | Ref  | Component                   |
|-----|--------------------------|------|-----------------------------|
| 2.1 | Pressure regulator       | 2.8  | Humid air flow controller   |
| 2.2 | Pressure gauge           | 2.9  | Humid air rotameter         |
| 2.3 | Charcoal filter assembly | 2.10 | Humid air selector valve    |
| 2.4 | Dry air flow controller  | 2.11 | Humid air test outlet       |
| 2.5 | Dry air rotameter        | 2.12 | Combined air selector valve |
| 2.6 | Dry air selector valve   | 2.13 | Combined air test outlet    |
| 2.7 | Dry air test outlet      | 2.14 | Combined air outlet to FLEC |

## Reading the panel

Use the flow controllers to adjust the channels; use the selector valves only to choose RUN or TEST routing. The pressure regulator locks when pushed in and unlocks when pulled out.

**Rotameter scale markings** are approximate indications. Do not assume an unverified scale division equals a flow in mL/min; establish the delivered flow with a reference instrument.

## Rear components

Identify the humidifier inlet and outlet before disconnecting tubing. The inlet must lead to the submerged frit; the outlet must draw air from the bottle headspace.



Figure 3. FL-1000 rear configuration with a condensate bottle and rear regulator.

| Position in photograph             | Component                                                       |
|------------------------------------|-----------------------------------------------------------------|
| Lower centre                       | Humidifier bottle, glass insert and supporting clamp            |
| Upper left                         | Condenser / condensate bottle with removable red cap            |
| Top centre                         | Stainless-steel mixing junction and mixed-air tubing            |
| Beside the humidifier on the right | Rear-mounted regulator with a separate pressure gauge           |
| Humidifier glass head              | Two tubing connections: inlet to frit and outlet from headspace |

**Retain the specified setting** of the rear regulator. The normal pressure adjustment described on page 8 refers to the front regulator (2.1).

**Before working at the rear**, isolate the air supply and confirm that the unit is fully depressurised. Support the glassware while releasing tubing or clamps.

# Installation

- 1. Inspect the delivery.** Retain the packaging until the unit has been checked. Remove transport tape from the glassware carefully. Look for cracked glass, loose fittings, damaged tubing or a displaced clamp. Report damage before use.
- 2. Position the unit.** Place it upright on a stable surface with access to the front and rear. Protect glassware and route tubing without sharp bends or tension.
- 3. Check the air source.** Use clean, dry air, preferably synthetic air, at 2-10 bar. Keep the source isolated and the FL-1000 regulator at zero during connection.
- 4. Connect the source tubing.** Connect 1/8-inch copper tubing to the designated 1/8-inch Swagelok air-supply inlet and the external supply. Identify the inlet on the actual unit. Use clean, compatible fittings and follow the fitting manufacturer's assembly instructions.
- 5. Prepare the humidifier.** With the unit fully depressurised, support the bottle, release it from its clamp and unscrew the red cap. Inspect and, if necessary, rinse with pure water. Add 400 mL of fresh pure, distilled water, refit the cap and secure the bottle in its clamp.
- 6. Check the condenser and tubing.** Confirm that the condenser is clean and clear of accumulated liquid. Verify the humidifier inlet and outlet connections and make sure the glassware is properly supported.
- 7. Prepare the outlet.** Use 1/4-inch PFA tubing and the 1/4-inch Swagelok connection for the FLEC supply (2.14). Keep the flow path open. Verify flow and humidity before starting sampling pumps.

## Final installation check

- Humidifier secured and filled with 400 mL pure water.
- Condensate bottle empty, clean and securely assembled.
- Tubing connected to the correct inlet and outlet paths.
- Front regulator at zero and an unobstructed discharge path available.

**Open the air source and increase FL-1000 pressure slowly**, especially at first use or after filter replacement. See Startup and flow measurement on page 8.

# Startup and flow measurement

## Set the pressure gradually

With the outlet path open and the selectors fully in their operating positions, open the external supply slowly. Pull the front pressure-regulator knob (2.1) out to unlock it, then turn it clockwise gradually. A typical working setting is 2 bar. Keep it at least 0.5 bar below the source pressure and within the 0-7 bar regulator range. Push the knob in to lock it.

**A 2 bar working setting** therefore requires a source pressure of at least 2.5 bar. Check for abnormal leakage or pressure behaviour before proceeding.

## Selector positions viewed from the front

| Selector          | RUN position                    | TEST position                    |
|-------------------|---------------------------------|----------------------------------|
| Dry air 2.6       | LEFT<br>Air to mixer            | RIGHT<br>Air to outlet 2.7       |
| Humid air 2.10    | RIGHT<br>Air to mixer           | LEFT<br>Air to outlet 2.11       |
| Combined air 2.12 | LEFT<br>Air to FLEC outlet 2.14 | RIGHT<br>Air to test outlet 2.13 |

**Normal RUN positions:** dry LEFT, humid RIGHT, combined LEFT. Never leave a selector in the middle or vertical position.

## Verify the flows

- 1. Stop the sampling pumps.** Diverting a supply stream changes the flow and humidity reaching the cell. Make these checks before sampling.
- 2. Check the dry stream.** Connect a suitable calibrated reference meter to outlet 2.7. Select dry TEST, allow the reading to settle and adjust the dry flow controller. Record the flow, then return the dry selector fully to RUN.
- 3. Check the humid stream.** Use outlet 2.11 and humid TEST. Use a meter suitable for humid air that does not create excessive backpressure. Adjust and record the flow, then return the humid selector fully to RUN.
- 4. Check the mixed stream.** With both channels in RUN, connect the meter to outlet 2.13 and select combined TEST. Verify the total flow and compare it with the sum of the individual readings.
- 5. Restore supply to the cell.** Return combined air to RUN. Remove test instruments as appropriate and verify that the normal cell path is open. Allow the delivered conditions to stabilise before sampling.

Use consistent flow-reference conditions for all readings. If the measured total differs materially from the channel sum, check routing, leakage and meter conditions before accepting the setup.

## Setting flow and humidity

Choose the total supply flow and target humidity required by the test procedure. Adjust both channels, then verify the mixed flow, relative humidity and temperature at the delivered conditions.

### Initial mixing calculation

Total flow = dry-air flow + humid-air flow

Approximate RH in percent =  $100 \times \text{humid-air flow} \div \text{total flow}$

This estimate assumes a dry stream near 0% RH and a humid stream near saturation, mixed at the same temperature and comparable pressure. It is an initial setting, not a substitute for a humidity measurement.

| Total flow<br>mL/min | Target RH<br>% | Dry flow<br>mL/min | Humid flow<br>mL/min |
|----------------------|----------------|--------------------|----------------------|
| 100                  | 50             | 50                 | 50                   |
| 200                  | 20             | 160                | 40                   |
| 200                  | 50             | 100                | 100                  |
| 200                  | 80             | 40                 | 160                  |
| 400                  | 50             | 200                | 200                  |
| 500                  | 50             | 250                | 250                  |

Examples are calculated starting points. The nominal unit range is 0-90% RH; attainable conditions must be verified for the actual setup.

### Respect the channel limits

The specified operating range is 0-250 mL/min per channel and 0-500 mL/min total. The separate 0-535 mL/min flow-controller specification does not increase these operating limits. At a total of 500 mL/min, both channels are at 250 mL/min, giving approximately 50% RH under the assumptions above. Other mixing ratios require a lower total flow.

### Set and verify the delivered conditions

- 1. Set the calculated channel flows.** Use the rotameters for coarse adjustment and the reference meter to verify both channels and the mixed flow.
- 2. Measure RH and temperature.** Check the mixed supply close to the cell inlet with a suitable calibrated instrument and a clean measurement arrangement.
- 3. Adjust the ratio if needed.** Increase the humid fraction to raise RH or the dry fraction to lower it. Recheck total flow after every ratio adjustment.
- 4. Wait for stable readings.** Allow the air supply, humidifier, tubing and cell to reach stable conditions. Begin sampling only when the method's acceptance criteria are met.

**Prevent condensation.** Keep the humidifier, tubing and cell at stable test conditions and avoid cooling the humid stream. Stop and investigate any visible liquid in the supply path.

# Sampling and shutdown

## Maintain the required flow balance

Supply air must cover the combined sampling flow and the excess flow required by the test procedure. The excess outlet between the FLEC sampling connections must remain open. Check actual supply and sampling flows using compatible reference conditions.

A practical starting example is a supply flow equal to 125% of the combined sampling flow. This is an operating example, not a universal acceptance criterion. Use the flow balance required by the named method.

| Example                                 | Flow       |
|-----------------------------------------|------------|
| Sampling tube A                         | 80 mL/min  |
| Sampling tube B                         | 80 mL/min  |
| Combined sampling flow                  | 160 mL/min |
| FL-1000 supply at 125% of sampling flow | 200 mL/min |
| Calculated excess flow                  | 40 mL/min  |

In this example, 100 mL/min dry air plus 100 mL/min humid air gives the required 200 mL/min supply and an initial estimate of 50% RH. Verify the final values before sampling.

## Before collecting samples

- Confirm that all selectors are in RUN and the FLEC supply and excess outlet are unobstructed.
- Verify supply flow, sampling-pump flows, RH and temperature against the test procedure.
- Check the cell seal and perform the required clean-air or system blank.
- Record unit identification, water condition, filter/service status, instrument identification and measured conditions.

## Stop and depressurise

1. **End sampling.** Stop the sampling pumps before stopping the cell supply. Handle and seal the sampling tubes according to the analytical procedure.
2. **Isolate the air source.** Close the external supply and reduce the FL-1000 pressure regulator to zero.
3. **Leave an open discharge path.** Allow residual air to escape through an unobstructed path until all pressure gauges read zero and flow stops.
4. **Prepare for storage or transport.** Only after complete depressurisation, drain the humidifier and condenser if the unit will be stored or moved. Clean and dry the glassware, protect clean connections and secure the components.

**Do not loosen fittings** to vent trapped pressure. Follow the pressure-release precautions on page 3 if the system does not depressurise normally.

## Routine maintenance

Isolate and fully depressurise the unit before cleaning or removing parts. Keep service materials, hands and tools from contaminating surfaces exposed to the air stream.

| When                          | Task                                                                                                                                                           |
|-------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Before use                    | Inspect glassware, tubing and clamps; check water condition and condenser liquid. Verify the conditions needed for the measurement.                            |
| Weekly during routine use     | Clean the humidifier bottle and replace the water with fresh pure water. Check and, if necessary, clean the condenser at the same time.                        |
| As needed                     | Clean the humidifier insert when deposits or restricted bubbling are observed. Investigate unstable humidity or elevated blank results.                        |
| Normally after about one year | Arrange reconditioning or replacement of the complete charcoal-filter assembly. Review earlier replacement when air quality, use or blank results indicate it. |
| After service or reassembly   | Check correct tubing, sealing and glassware support. Recheck flow, humidity and the required blank before measurement.                                         |

### Humidifier bottle

Support the bottle and release it from its clamp. Unscrew the red cap and remove the bottle without straining the insert or tubing. Use a suitable laboratory-glassware cleaning procedure, rinse thoroughly with pure water and remove cleaning residues. Refill with 400 mL fresh pure, distilled water, then reassemble and secure the bottle.

### Condenser

The rear configuration on page 6 uses a removable condensate bottle. With pressure fully released, support the bottle and carefully unscrew it from its cap without twisting the glass head or straining the tubing. Empty and clean the bottle using a suitable laboratory-glassware procedure, then rinse thoroughly with pure water.

**Reassemble the condensate bottle empty.** Check the seal, support and tubing, and confirm that the air path is clear. Do not fill it with the humidifier water charge.

### Air cleanliness and records

Filter service life depends on the source air and operating conditions. The typical one-year interval does not guarantee blank performance. Record water changes, cleaning, filter replacement, instrument checks and corrective actions. Use the blank limits and calibration schedule required by the test procedure.

# Filter and humidifier insert

## Replace the filter as a complete assembly

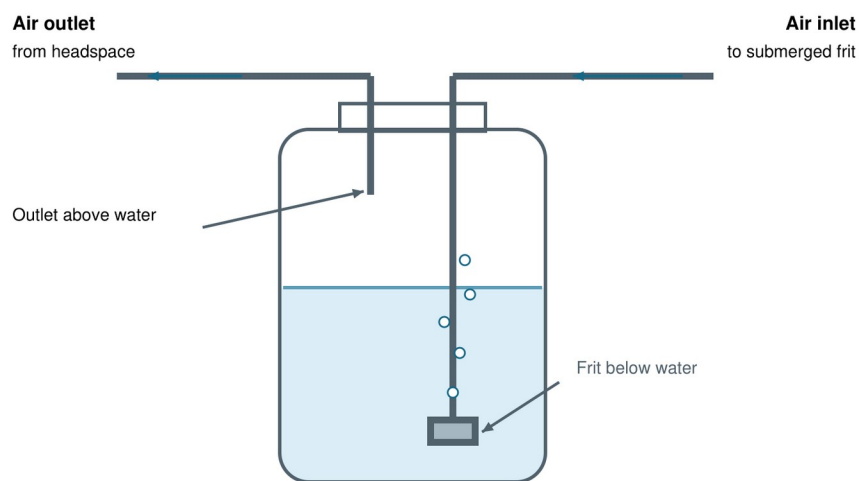
Never dismantle the filter housing or undo the top fitting. Isolate the source and confirm complete depressurisation. Support the assembly and disconnect it using the connections beneath the unit. Return the complete assembly to CHEMATEC or the authorised supplier for reconditioning or replacement.

- 1. Identify the assembly connections.** Confirm the connections beneath the actual unit before releasing them; protect adjacent tubing and glassware.
- 2. Support the filter.** Release only the assembly connections. Keep the filter housing and its top fitting intact.
- 3. Protect clean connections.** Prevent dirt from entering the disconnected air path while the filter is away for service.

Install the replacement assembly by reversing the removal procedure. Check the fittings and support, then pressurise slowly. Verify leakage, flow and blank performance before returning the unit to use. Replacement filter product code: FL-1000-01.

## Clean and reconnect the humidifier insert

After depressurising, identify and label the inlet and outlet tubing before disconnecting them. Release both connections and gently lift the insert from the main bottle cap. Clean only when needed, using a suitable laboratory-glassware procedure and a thorough pure-water rinse.



Schematic only. Identify the actual glass passages before reconnecting tubing.

**Figure 4. Correct humidifier inlet and outlet paths.**

Reconnect the humid-air inlet tubing to the side arm leading to the frit at the bottom of the humidifier. Reconnect the outlet tubing to the headspace side. Make both glass-insert connections finger-tight; do not apply excessive force.

**WARNING** Reversed tubing can force water into the air path and contaminate the system. Check the actual glass passages before restoring air pressure.

# Troubleshooting

Stop sampling whenever supply conditions become uncertain. Depressurise before inspecting internal connections or removing parts. After correction, recheck the affected conditions before resuming a measurement.

| Symptom                              | Checks and action                                                                                                                                                                                                                                           |
|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| No flow or low flow                  | Check the external supply and regulated pressure. Confirm that each selector is fully in the required position and the flow controllers are open to the required setting. Check tubing, connections and downstream restrictions.                            |
| Pressure rises or safety valve opens | Set the FL-1000 regulator to zero immediately, isolate the source and stop sampling. After pressure release, check for a middle-position selector, blocked outlet or restrictive instrument. Inspect glassware; do not restart until the cause is resolved. |
| Humidity below the target            | Check the water charge, humid-channel flow and inlet connection to the submerged frit. Check for leaks or poor bubbling. Allow temperature and readings to settle, then verify with the humidity instrument.                                                |
| Humidity high or unstable            | Check the dry/humid ratio, water condition, temperature changes and condensation. Verify the humidity instrument and total flow after adjustment.                                                                                                           |
| Liquid water in the outlet tubing    | Stop operation. Depressurise, check for reversed humidifier tubing, inspect the condenser and check for condensation. Clean affected components and confirm acceptable blank and operating conditions before use.                                           |
| Mixed flow differs from channel sum  | Confirm both channel selectors are in RUN during the mixed-flow check. Check leaks and reference-meter suitability, including humidity, pressure, temperature and flow-reference conditions.                                                                |
| Blank result is elevated             | Check source-air quality, water, cleaning residues, tubing and filter condition. Locate the contamination through the laboratory's blank procedure. Service or replace affected components and repeat the blank.                                            |
| Pressure remains after isolation     | Do not open the filter or loosen fittings. Keep the assembly intact, check that an outlet path is unobstructed without dismantling and contact CHEMATEC if normal pressure release cannot be confirmed.                                                     |

## When requesting support

Provide the product code, serial number if marked, a description of the symptom, source and regulator pressures, valve positions, measured flows and humidity, and recent cleaning or service history. Clear photographs of the front and rear connections help identify the setup.

## Technical specifications and support

| Parameter                           | Specification                                         |
|-------------------------------------|-------------------------------------------------------|
| Product                             | FL-1000 FLEC Air Control                              |
| Weight                              | 9.0 kg                                                |
| Dimensions H × W × D                | 560 × 310 × 225 mm                                    |
| Materials in contact with humid air | Acid-resisting stainless steel, PFA and glass         |
| Air-supply connection               | 1/8-inch Swagelok; 1/8-inch copper tubing             |
| Connection to FLEC Cell             | 1/4-inch Swagelok; 1/4-inch PFA tubing                |
| Pressure regulator                  | 0-7 bar maximum                                       |
| Operating flow per channel          | 0-250 mL/min                                          |
| Total operating flow                | 0-500 mL/min                                          |
| Flow-meter specification            | 0-250 mL/min; approximate panel indication            |
| Flow-controller specification       | 0-535 mL/min; observe operating flow limits           |
| Relative humidity                   | 0-90% RH; verify actual delivered conditions          |
| Humidifier water charge             | 400 mL pure water                                     |
| Condenser on illustrated unit       | Glass condensate bottle marked 100 mL nominal         |
| Safety valve                        | Opens above 1 bar in the humidifier; reseals at 0 bar |
| Filter                              | Replaceable assembly containing activated charcoal    |
| Required air supply                 | Clean, dry air, preferably synthetic air, at 2-10 bar |
| Required water                      | Pure water; distilled water for routine filling       |

Flow and humidity ranges are subject to the dry/humid mixing limits described on page 9. Regulator pressure and humidifier safety pressure refer to different parts of the unit.

### Current FL-1000 product information

### Technical support and replacement parts

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Quote FL-1000 for the air-control unit and FL-1000-01 for the replacement charcoal-filter assembly. Include the serial number if marked when requesting parts or service.

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