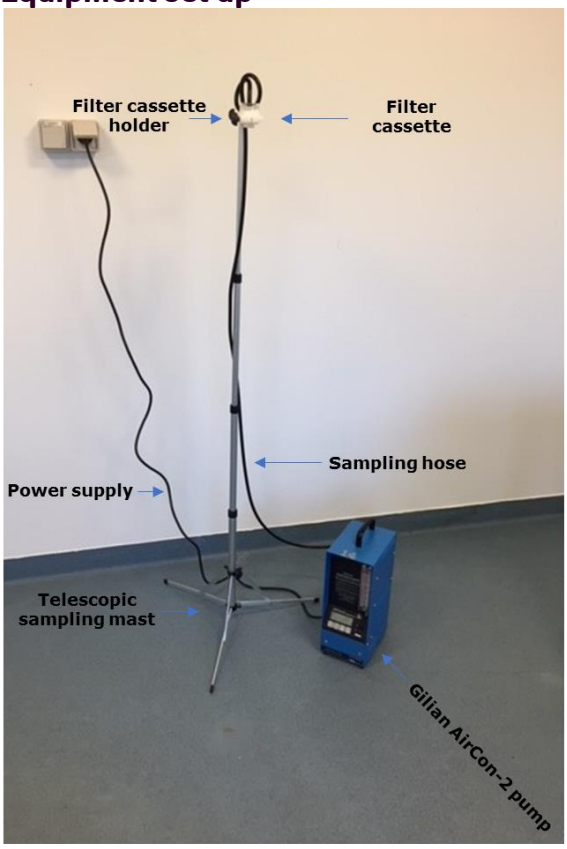
How to conduct air monitoring

This document is a guideline on how to conduct air sampling by using Gilian AirCon-2 air sampling pumps. The guideline describes best practices from Novozymes A/S by providing a detailed description of the required equipment, a step-by-step guide to the sampling and analysis of the samples.

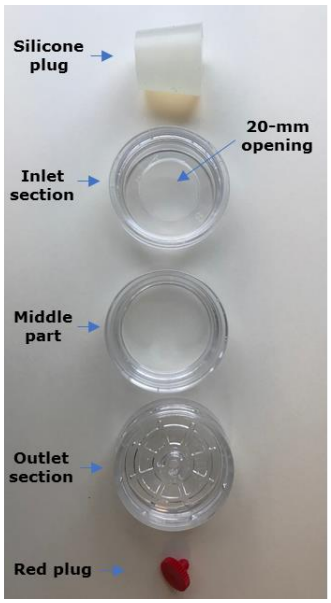
Equipment set up

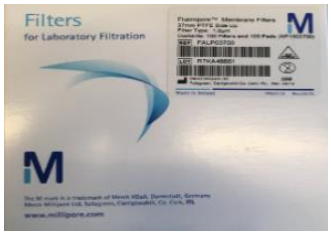
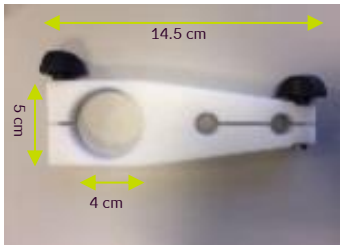


Equipment set up for air sampling by using Gilian AirCon-2 pumps.

Required equipment

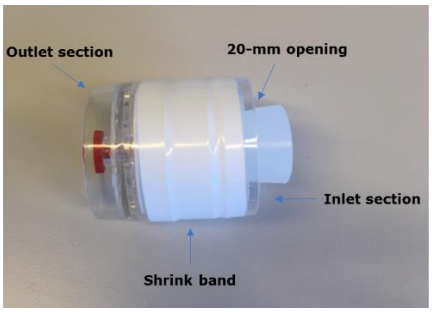
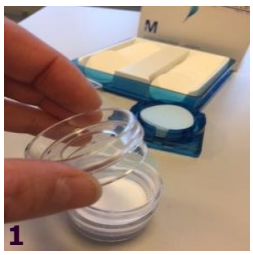
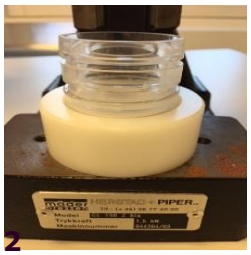
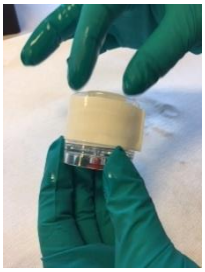
The following list represents the supplies and equipment that are needed for air monitoring by Gilian AirCon-2 pumps. The list contains vendors used by Novozymes, but others might be able to provide the same services. Novozymes has a long experience with Gilian AirCon-2 pumps but other alternatives are available, see “Standards and industry guidelines” on the homepage of A.I.S.E (International Association for Soaps, Detergents and Maintenance Products).

Item	Specifications	Supplier
Gilian AirCon-2 pump 	High volume air sampling pump (2-30 LPM) with sampling hose and adjustable telescopic sampling mast (150 cm). Power module and charger must be ordered separately.	Sensidyne; Cat. no.: 801012 Cat. no.: 801000-1
Filter cassette  	Three-piece 37 mm filter cassette The cassette consists of an inlet section and an outlet section. The inlet section is custom-modified to obtain a 20-mm opening. Running the pump at 25 L/min, the 20-mm opening will give an air flow rate at 1.25 m/s corresponding to normal breathing.	Sensidyne; Cat. no. GCO37050 Custom modification for the 20-mm opening is needed. The conical silicone plug (18-22 mm) is not included. It can be purchased from a laboratory equipment supplier
Shrink band 	Shrink band for filter cassettes (37 mm)	Sensidyne; Cat. no. GCO37DNL

Filters 	Fluoropore membrane filters (37 mm) and support pads, PTFE, hydrophobic, pore size 1.0 µm	Merck; Cat. no. FALP03700
Filter cassette holder 	The filter holder connects the filter cassette with the telescopic sampling mast.	Custom made; A local craftsman should be able to produce a similar tool.
Toggle Press 	Hand-operated air press for ensuring a leak tight fit of the assembled filter cassette. Pressure: 1.5 kN	Mäder Pressen;

Preparation of filter cassettes

This section will provide a step-by-step guide to the loading, assembling and sealing of filter cassettes. The filter cassette will hold the filter securely in place during air sampling.

Step	Action
	Assembled filter cassette: 
1	**Loading**    • To load the three-piece filter cassette, place a support pad into the outlet section of the cassette (1) • Add a filter on top of the support pad with the grid side facing the pad (2, 3)
2	**Assembling**    • Fit the middle part and the inlet section onto the outlet section and press down gently (1) • To ensure a leak tight fit, press the assembled cassette by a toggle press (2) • Insert the small red plug into the outlet section and the large conical silicone plug into the inlet section of the cassette (3)
3	**Sealing & Assigning**     • Seal the filter cassette with cassette shrink band • Assign a unique ID to each of the prepared filter cassettes • Let the filter cassettes **dry completely** before placing in a zip lock bag for storage at room temperature until use

Air sampling

The following provides a step-by-step guide to the air sampling procedure by AirCon-2 pumps.

Step	Action
	For supplemental information see the e-learning “Enzyme exposure air measurements” by following the link: https://www.novozymes.tv/search/perform?search=air
1	When ready to start sampling, remove the plugs from the filter cassette and place them in a zip lock bag to avoid contamination.
2	Insert the filter cassette into the filter cassette holder with the cassette facing **down**. If necessary, the cassette can be secured with duct tape.
3	Connect the outlet section of the filter cassette to the inlet of the AirCon-2 pump by using the sampling hose. The filter cassette is placed near the breathing zone of the operator to simulate the nose of the operator.
4	Fill in a sample registration form for each filter cassette used for air monitoring (See Appendix 1).
5	Start the sampling by pushing: • “On/Off” • “Accept” • “Hold” • “Run” Adjust the air flow on the sampling pump to 25 L/min and fill in the registration form with: • The start time of sampling • Initial air flow rate The sampling time must reflect the duration of the actual working operation – recommended sampling time is 30 min. *IMPORTANT: Note any other pertinent sampling information*
6	Stop sampling by pushing: • “Hold” Fill in the registration form with: • Ending time • Final air flow rate Turn off by pushing: • “On/Off” *IMPORTANT:* Note any other pertinent sampling information
7	After sampling: • Remove the filter cassette • Insert the plugs into the inlet and outlet section of the cassette and place the cassette in the zip lock bag. Make sure that the plug does not touch the filter. *IMPORTANT:* The filter cassettes can be stored at 0-10 °C for 1-2 weeks and at -20 °C for long-term storage

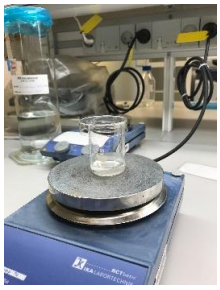
Cleaning of equipment

Step	Action
1	After the completion of sampling, the AirCon-2 pump housing is cleaned with a humid cloth
2	The foam rubber pad on top of the pump is removed, rinsed with water, dried and placed in the pump housing
3	The sampling tube is rinsed in water with detergent and dried completely before next use
4	The filter cassette holder and sampling mast are cleaned with a humid cloth

Analysis of filters

The collected air monitoring filters are eluted in 5 mL 0.01 M PBS, 0.023% Brij 30 (v/v), 0.5% BSA (w/v), pH 7.4 buffer for 30 min with magnetic stirring at room temperature. If the target enzyme is a protease, a protease inhibitor must be added to the elution buffer.

The analysis of filters from the air monitoring requires access to an immunochemical analytical method for the target enzyme. For several Novozymes' enzymes, the analysis can be conducted by the dedicated commercially available simple and fast point-of-use analytical assay MICT® (Magnetic Immuno-Chromatographic Test), which is provided by MagnaBioAnalytics, LLC (MBA). MBA can also provide ready-to-use elution buffer and protease inhibitor solution. If the requested analysis is not available, MBA may in collaboration with Novozymes be able to develop a new analytical method. Ask your Novozymes' contact person for more information about filter analysis or contact MBA for more information about MICT® (http://www.magnabioanalytics.com).

Analysis	Supplier
Filter elution • Place the intact filter in a beaker • Add a small magnet • Add 5 mL elution buffer (0.01 M PBS, 0.023% Brij 30 (v/v), 0.5% BSA (w/v), pH 7.4) • Add protease inhibitor to the elution buffer if the target enzyme is a protease • Stir for 30 min at RT	 • The elution buffer and protease inhibitor solution can be purchased from MBA
Filter analysis • Novozymes have in collaboration with MBA developed the commercially available point-of-use assay, MICT®, for the detection and quantification of enzymes in industrial environments	 • MICT is provided by MBA

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Appendix 1

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Enzyme monitoring data registration form:

Pump ID			**Sample no. / ID**				
Company name and address							
Monitoring carried out in working area/position							
Sampling time	**Start time**		**Sampling time (pump display)**		**Air flow rate (25 L/min)**	**Start**	L/min
	Stop time					**Stop**	L/min
Picture taken of the set up?		Yes ☐	**If no picture is taken: Describe the position of the filter cassette:**				
		No ☐					
Enzyme product(s) used during sampling	**Type**						
	Amount						
Observations/notes (e.g. facility hygiene level)							
Date & name (or initials)							