

English translation of the official document from Biochemie Lab S.r.l. (for the original document, please refer to the "certificazioni" in italian language section)

Campi Bisenzio, 06/06/2025

Technical Report N°: 2510848.001-004 of 06/06/2025

Dear
COLOROBbia CONSULTING S.R.L.
VIA PIETRAMARINA, 53
50053 SOVIGLIANA - VINCI (FI)

SAMPLE DATA

Identification Data: ADV Prototype – formaldehyde abatement test

Sampled by: Biochemie Lab S.r.l. technical staff (PO 20 rev. 6 of 01.12.2021, excluded from ACCREDIA accreditation)

Sampling Date: -



Figure 1: Abatement Chamber Setup

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The laboratory received a request to test the abatement effectiveness of volatile pollutants by the Colorobbia prototype, which uses photocatalytic technology. The chosen analyte for the test was Formaldehyde (CAS# 50-00-0), to be monitored over an 8-hour period.

For the tests, the laboratory utilized its existing 1 m³ cubic chamber, which features access ports for cabling, injection, and sampling.

The two access ports for cables (Fig. 4) are sealed with Teflon tape to ensure the chamber's integrity. The upper access ports, however, are of two types:

- One injection port equipped with a pierceable septum (Fig. 2), used for introducing doping materials or for taking samples with a gas-tight syringe.
- Two ports fitted with gas taps (Fig. 3), for sampling using dedicated pumps.

All the ports described above are positioned off-center relative to the chamber's central axis to avoid interfering with the equipment placed in the middle.



Figure 2: Injection Port



Figure 3: Sampling Port

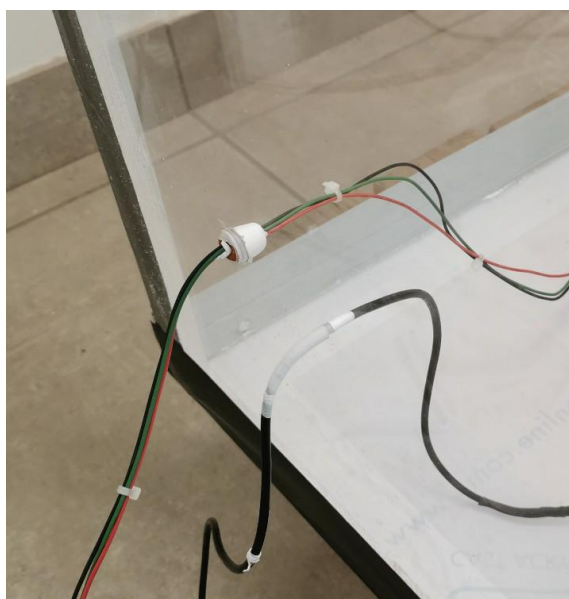


Figure 4: Wiring Ports

To contaminate the chamber, a certified formaldehyde standard at 37% in water was used, with an added 15% proportion of methanol as a stabilizer. Between tests, the chamber was kept open with forced ventilation from a high-flow fan to allow for decontamination.

During sampling, performed using a low-flow personal sampling pump, the volume exiting the pump was simultaneously reintroduced into the chamber to avoid diluting its internal content. Time zero, after contamination, was sampled 1 hour after the actual doping.

The sampling technique is based on the in-situ derivatization of the analytes to trap and stabilize them, followed by chemical desorption with appropriate solvents. The chosen reaction for derivatization is with 2,4-dinitrophenylhydrazine (DNPH), which selectively reacts with carbonyl compounds such as aldehydes and ketones to form stable adducts (Fig. 5). Specifically, the derivatizing agent is already adsorbed in the sampling cartridge, which is made of ultra-pure silica. Consequently, the reaction is immediate as the formaldehyde-containing flow passes through, fixing the contaminant inside the vial (Fig. 6).

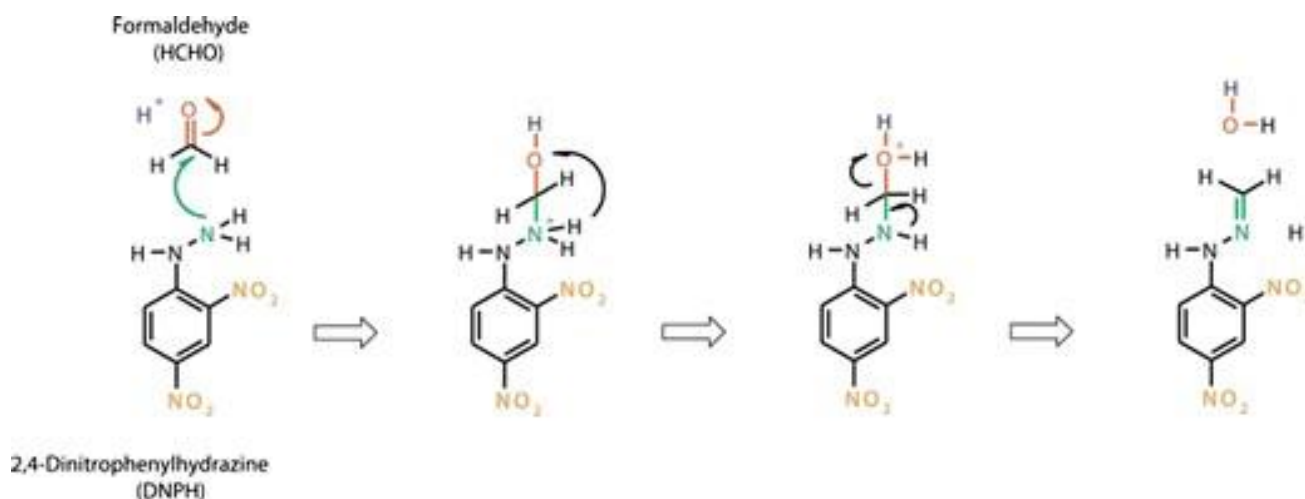


Figure 5: Reaction between Formaldehyde and DNPH

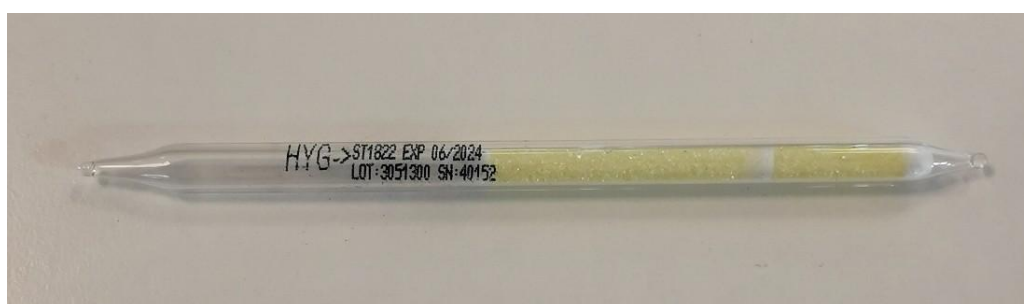


Figure 6: Cartridge with Derivatizing Agent

The various sampled vials are then desorbed with solvent and injected into a High-Performance Liquid Chromatography (HPLC) system coupled with a triple quadrupole mass spectrometer. The chosen technique adds an extra layer of identification beyond chromatographic separation. This is because the ionization and fragmentation induced within the spectrometer are specific to each molecule, making them free from potential interference from different substances in this case.

Below are the sampling conditions and chromatographic equipment used for detection:

- Sampler: Life XP, Mega System
- Sampling Flow: 0.2 l/min
- Total Sampling Volume: 1 l
- Sampling Duration: 5 min
- Desorption Solvent: Acetonitrile (CAS# 75-05-8)
- HPLC: Agilent Infinity 1290 equipped with autosampler and column thermostat (Fig. 7)
- Mass Spectrometer: Agilent QQQ 6495C or equivalent (Fig. 7)
- Chromatographic Column Used: Zorbax Eclipse Plus C18 2.1x100 mm, 1.8 µm with Zorbax Eclipse Plus C18 2.1x5 mm, 1.8 µm pre-column.



Figure 7: HPLC-MS System

ANALYTICAL RESULTS

-Abatement Test

Only the abatement effectiveness of the photocatalytic filter for the analyte was evaluated.

The actions taken to verify the actual abatement were as follows:

- Chamber sealing and blank sampling
- Introduction of formaldehyde and activation of the internal chamber fan for 1 hour.
- Switching off the internal fan and waiting 1 minute before performing the t₀ sampling.
- After completing the t₀ sampling, turn on the prototype.
- Subsequent samplings at the indicated times and under the same conditions as t₀.

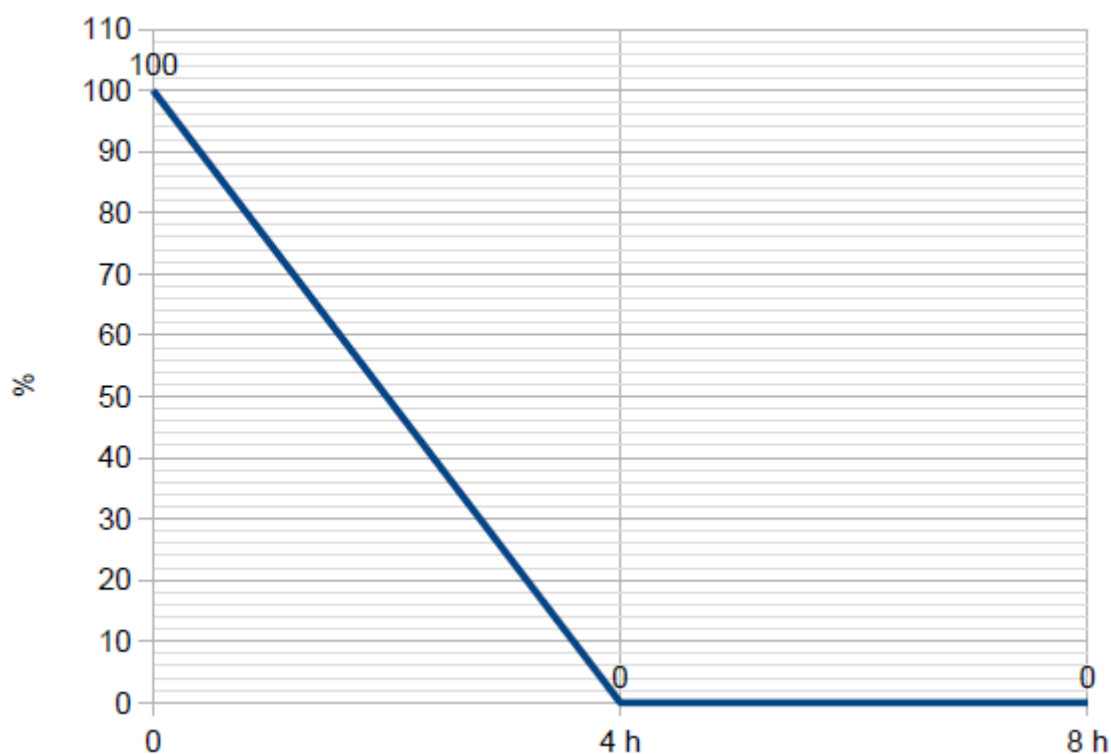
The abatement and decay graphs show the percentage abundances normalized to the value found at time t₀ versus the elapsed time in hours.

Below are the device settings and sampling steps:

- Flow rate set on the prototype: 80 m³/h
- Doping value: 100 ppbV
- Samplings performed (Active Abatement): t₀; 4 h; 8 h

Formaldehyde Abatement 80 m³/h

Formaldehyde % Trend



Graph 1: Relative Formaldehyde Abatement Over Time – 80 m³/h