# Analytical Method Validation Study of 1,2-Dichloropropane on Charcoal-Based Dermal Collection Patches

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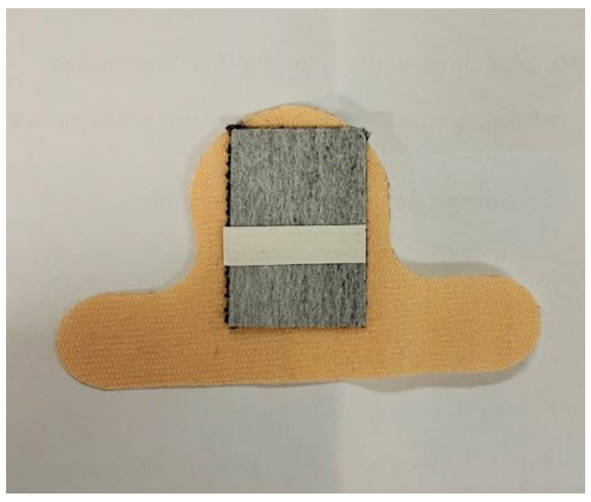
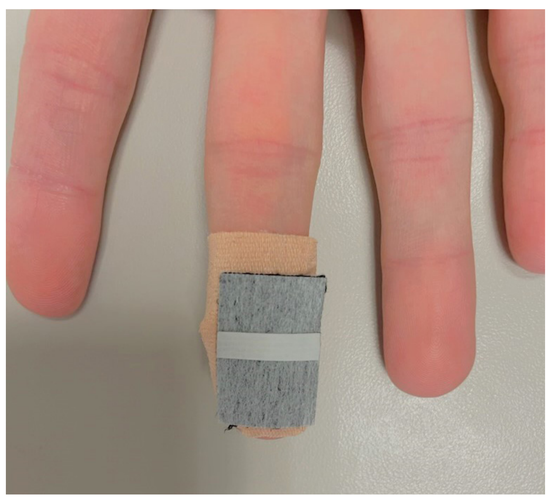
## Introduction

Toxic Substances Control Act section 4 test orders issued in 2021 highlighted the lack of validated sampling methods for measuring dermal exposure to volatile organic compounds (VOCs). Traditional dermal wipe methods are often inadequate due to VOCs' high vapor pressure.

## Study Objective

Develop and validate a gas chromatography–tandem mass spectrometry (GC-MS/MS) method for measuring 1,2-dichloropropane (PDC) on PERMEA-TEC dermal sensor pads, commonly used to evaluate chemical breakthrough in glove efficacy testing. The analytical method developed can be used to measure vapor-on-skin exposure underneath gloves.





## Methods

**Sample Media and Preparation:**

- PERMEA-TEC charcoal-based dermal sensor pads (SKC, Inc.)
- Backing removed and pads placed in 20-mL scintillation vials and spiked with a PDC-fortified solution

**Extraction:**

- **Solvent**: Carbon disulfide (1,2-dichloropropane-d6 internal standard)
- **Volume**: 5 mL
- **Technique**: Flatbed shaker on high for 6 hours

**Analytical Method:**

- **Instrument**: Gas chromatography–tandem mass spectrometer
- **Column**: ZB-WAXplus, 30 m x 0.32 mm i.d. x 0.50 µm film
- **Carrier/oven program**: He @ 4.0 mL/min constant flow 35°C (4 min hold) increase 25°C/min to 160°C (2 min hold)
- **Injection**: 2.0 µL, split ratio 5:1 @ 200°C
- **MS parameters**: Multiple reaction monitoring mode

| Compound | Transition (m/z) |
|---|---|
| PDC | 112 > 63 |
| | 112 > 41 |
| PDC-d6 | 118 > 65 |
| | 118 > 41 |

**Validation Parameters:**

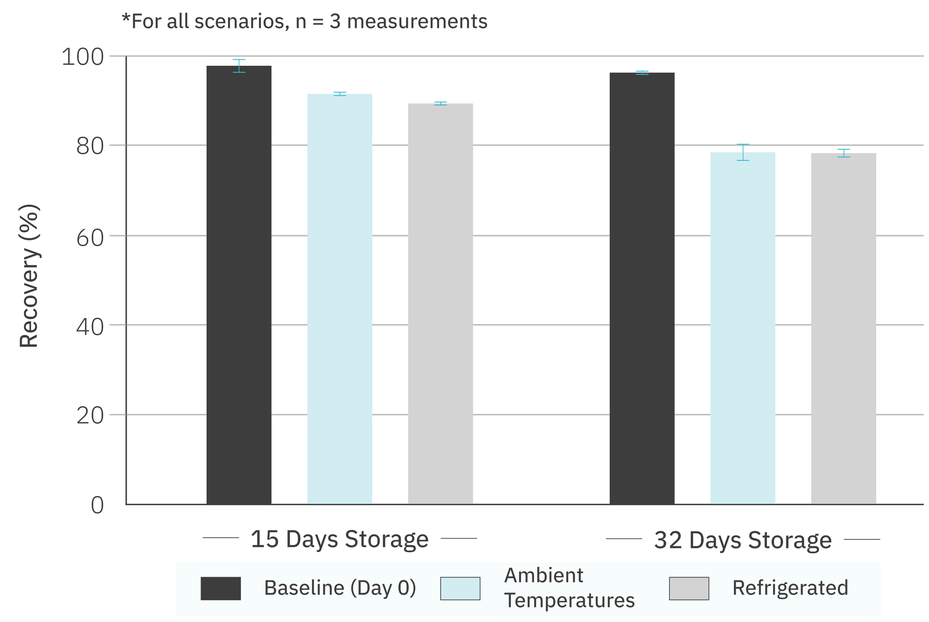
- Linearity (intra- and inter-day) assessed by constructing calibration curves from standards at eight different concentrations of PDC ranging from 0.01 to 2.0 µg/mL.
- Precision, accuracy/recovery, and limit of quantitation (LOQ) assessed via five replicates each spiked with 0.5–5 µg/pad.
- Limit of detection (LOD)* determined from seven preparations at the target concentration of 0.15 µg/pad.
- Stability up to 32 days at room temperature or refrigerated measured with three replicates per condition and duration.

*The LOD was developed to evaluate exposures at or below the ECHA's long-term, derived no effect level (DNEL) for workers (1.03 mg/kg-day), which was back-calculated to a skin loading dose of 7.2 µg/cm$^2$.

## Results

The method performs well and is suitable for the determination of PDC extract concentrations from 0.010 to 2.0 µg/mL.

- LOD: 0.187 µg/pad | LOQ: 0.5 µg/pad
- Average recovery from media was 87%
- Acceptance criteria met for linearity and precision: ~80–120% refit and relative standard deviation < 20% and linearity $R^2 \geq 0.99$
- Up to 32 days, recovery was acceptable (70–120% threshold) when stored at ambient temperatures or refrigerated




## Discussion

- This study was conducted to evaluate a method for assessing vapor exposure under gloves in closed-system operations.
- Because the open pad design can absorb vapor that may not interact with the skin, the method may overestimate exposure in vapor-only scenarios.
- There is a risk of underestimation if pad saturates with sweat or chemical splashing.
- Field usability has not yet been assessed; some concern for potential interference with the pad during glove donning and doffing.
- While there are no existing dermal limits for PDC in the U.S., the results can be converted to a skin loading dose and internal exposure and compared against the European Chemical Agency's (ECHA) derived no effect level (DNEL) for repeated dose exposure in workers.
- Future research could include simulated field conditions (measuring uptake under glove).

## Conclusion

There is no harmonized sampling method for assessing dermal exposure to volatile substances. The method evaluated in this study is **a workable step forward** in having a field deployable sampling approach where empirical exposure data are required. The method is optimized for measuring vapor exposure under gloves in nondirect contact scenarios for PDC.

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