Philip Morris Products S.A.
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Analysis of propylene oxide in Platform 1 Aerosol

PRODUCT TESTING LABORATORY AND GOVERNANCE

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1. ANALYSIS OF PROPYLENE OXIDE IN PLATFORM 1 AEROSOL

1.1. Abstract

The aerosols are generated on a linear smoking machine and collected using Cambridge filter pad (CFP) followed by two impingers filled with 5 mL of toluene. After the smoking process, the CFP is discarded and the contents of the two impingers are combined and delivered to the analytical laboratory for addition of internal standard and analysis.

The extracts are analyzed by Gas Chromatography with Mass Spectrometry detection (GC-MS) using a column Agilent Pora Bond Q 25 m x 0.25 mm ID x 3 µm film thickness.

Results are expressed as µg/item for P1.

1.1. Applicability

The method described is used to determine propylene oxide (PO) in aerosol from Platform 1 (P1) under Health Canada (HC) and International Organization for Standardization (ISO) smoking conditions, as well as under alternative smoking regimens.

1.1. Reagents

- Toluene
- Propylene oxide, certified
- 1-2 propylene oxide-d6, stabilized with hydroquinone

1.2. Aerosol generation

P1 items are conditioned in climatized chamber for at least 48 hours at target conditions of 22 ± 1°C and relative humidity of 60 ± 3% before used for aerosol generation.

Cambridge filters are conditioned for at least 12 hours at target conditions of 22 ± 1°C and relative humidity of 60 ± 3% before used for aerosol generation.

The aerosol samples are generated on a linear smoking machine under ISO and HC smoking regimens and collected using a Cambridge filter pad and two impingers filled with 5 mL of toluene. The two impingers are immersed into a dry ice-isopropanol bath at -75± 3°C. The collection conditions for the different smoking regimes are summarized in Table **1**.

At the end of the smoking process the glass fiber Cambridge filter pad is discarded and the contents of the two impingers are mixed into a Filtrona tube.

Four replicates for each sample are generated. Two blanks are smoked each smoking day to ensure that no contamination is carried out. The first blank is smoked before the first aerosol collection, while the second one is smoked at the end of the smoking day.

Table 1: Aerosol Collection Condition

Regimen	Accumulation number	Puff number	Regimen Condition [puff volume/Puff duration/Puff Interval] [ml/s/s]
ISO	7	6	35/2/60
HC	5	12	55/2/30

1.3. Samples preparation

Aerosol extracts generated by the aerosol collection laboratory do not need any further preparation step. Sample vials are prepared by mixing 1000 µL of the aerosol extracts with 100 µL of internal standard solution.

1.4. Internal standard solution

The internal standard solution consists in a solution of deuterated propylene oxide (PO-d6) in toluene.

1.5. Calibration solutions preparation

A 10 µg/mL propylene oxide is prepared by dilution of the certified reference material in toluene.

Seven standard (STD) solutions are prepared by dilution of the proypylene oxide solution in toluene. The range of concentrations covers the range relevant for analysis and is provided in

Table **2**.

The corresponding vials are prepared by mixing 1000 µL of standard solution with 100 µL of internal standard solution.

Table 2: Typical concentrations of propylene oxide calibration standards

	Propylene oxide.
Level	(µg/mL)
1	0.02
2	0.10
3	0.25
4	0.50
5	1.00
6	1.50
7	2.00

The standard level 5 is also used as quality check.

1.6. Instrumental Conditions

The samples are analyzed by Gas Chromatography (GC) with mass spectrometry detection (MS) following tables below:

Table 3: Instrumental conditions for determination of ethylene oxide and vinyl chloride

Column	Agilent Pora Bond Q 25 m x 0.25 mm ID x 3 µm film thickness
Oven temperature	35°C, hold time 2 min 15°C/min→150°C, hold time 0 min 30°C/min→300°C, hold time 10 min
Run time	25 min
Injection mode	Splitless, 1 min
Injector temperature	200 °C
Injection volume	1 µL
Carrier gas flow	2.0 mL/min
Gas	Helium
Transfer line temperature	250 °C
Source temperature	230 °C
Quadrupole temperature	150 °C
Detector source	Electron Impact

1.7. Testing procedure

The following typical analytical sequence is used for the determination of propylene :

- Calibration curve (STD 1 to 7)
- Solvent (toluene)
- 2 smoked blanks
- Samples
- After every 5 samples, inject a quality check (STD level 5)
- Always end an analytical sequence with a quality check

1.8. Verification of results

1.8.1. Calibration curve verification

A calibration curve is used to quantify the unknown samples using the response ratio of analyte to the internal standard. The peak area ratio is applied to generate the curve. The linear regression is calculated automatically by the instrument software Mass Hunter. Specific information about regressions are provided in Table 4:

Table 4: Parameters used for calibration curve

Compound	Internal standard	Regression type	Weighting factor	R^2
Propylene oxide (PO)	1,2-propylene oxide-d6	linear	1/x	≥ 0.995

1.8.2. Quality check

The validity of the calibration is continuously verified during the batch analysis by ensuring that the injected quality check (STD level 5) is within ±10% of its theoretical value.

1.9. Example Chromatograms

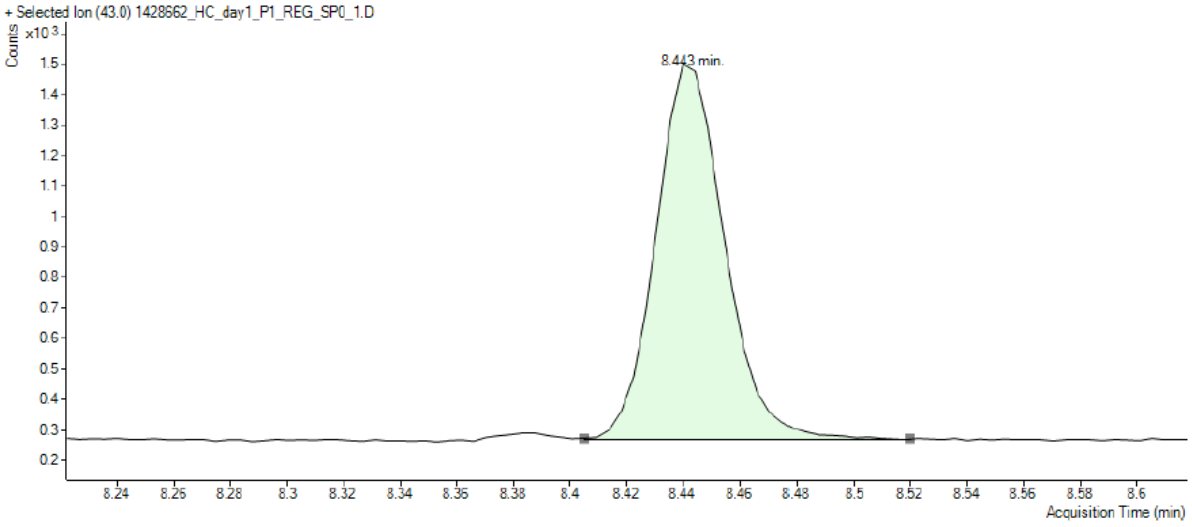

Figure 1: Extracted ion chromatogram for propylene oxide (43.0 amu) in P1 sample

1.10. Limit of Detection (LOD) / Lower Limit of Quantitation (LLOQ)

The LOD and LLOQ were both calculated in terms of the standard deviation of five different measurements of the lowest calibration standard for all other analytes produced under intermediate precision conditions (five different preparations from at least two different operators and analyzed on five different days).

$$LOD = 3 \times SD_{level1}$$

$$LLOQ = 10 \times SD_{level1}$$

Level 1 is the lowest calibration level.

Detailed results are provided in Table 5.

Table 5: Limits of Detection and Quantitation (HC and ISO regimens)

		HC regimen			ISO regimen		
Matrix	Compound	LOD [µg/item]	LLOQ [µg /item]	STD1 [µg /item]	LOD [µg/item]	LLOQ [µg /item]	STD1 [µg /item]
P1	propylene oxide	0.0030	0.0100	0.0400	0.0021	0.0071	0.0286

1.11. Repeatability limit (r) and Intermediate precision limit (IP)

$$r = 2 \cdot \sqrt{2} \cdot s_r$$

$$IP = 2 \cdot \sqrt{2} \cdot s_{IP}$$

s_r is the standard deviation of repeatability.

s_{IP} is the standard deviation of intermedidate precision.

Repeatability limit and intermediate precision limit are determined during four different days using different smoking machines and standard solutions preparation. Different operators are involved in the aerosol generation and analysis.

Table 6: Repeatability r and Intermediate precision IP for ISO and HC smoking regimens

		HC regimen			ISO regimen		
Matrix	Compound	r [µg/item]	IP [µg /item]	Mean [µg /item]	r [µg/item]	IP [µg /item]	Mean [µg /item]
P1	propylene oxide	0.0213	0.0300	0.182	0.0305	0.0527	0.139

1.12. NORMATIVE REFERENCES

- ISO 3308:2000 – Routine analytical cigarette smoking machine – definitions and standard conditions
- ISO 3402:1999 – Tobacco and tobacco products – atmospheres for conditioning and testing