Greenpeace Research Laboratories Analytical Results 2018-04

Identification of polymer type used for a selection of tampon applicators and their packaging on sale in the UK, and screening of applicators for chemical additives and contaminants

August 2018

Introduction

Individual boxes of four widely available brands of tampons were received by the Greenpeace Research Laboratories from a private individual for analysis in November 2017. Details of the products received are listed in Table 1. The focus of the analyses requested was the polymer (plastic) applicator in each case, rather than the absorbent material itself.

For each sample, freshly removed from its individually-sealed outer packaging/wrapping, a small section from the tip of the applicator was removed and subject to analysis using Fourier-Transform Infrared (FT-IR) spectroscopy in order to identify the polymer from which it was made. A section of the packaging in which each applicator was individually wrapped was also subject to the same analysis. In addition, a separate section from the tip of each applicator was subjected to Gas Chromatography – Mass Spectrometry (GC-MS) screening for the presence of organic (carbon-based) chemical additives or contaminants, using qualitative (i.e. non-quantitative) environmental forensics techniques.

Sample description	GRL laboratory code
Kotex Security (Super)	NGP17001
Playtex Gentel Glide 360	NGP17002
Tampax Pearl	NGP17003
Corman Organyc (Compact)	NGP17004

Table 1: details of samples received and analysed at the Greenpeace Research Laboratories

Materials and methods

Fourier-Transform Infrared (FT-IR) analysis of the applicators and their individual packaging was conducted using a PerkinElmer Frontier spectrometer with a universal diamond-ATR attachment, and using a number of commercially available and custom-built spectral libraries to assist identification of polymer type from the spectra obtained.

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For the qualitative organic chemical analysis, semi-volatile organic compounds (sVOCs) were isolated from samples by incubating small sections (approx. 2g each) with a mixture of pentane and acetone in a sonic bath at 60 'C for 1 hour. Extracted compounds were subsequently identified as far as possible using gas chromatography/mass spectrometry (GC-MS) operated in both SCAN and SIM modes.

More detailed descriptions of the sample preparation and analytical procedures are presented in Appendix 1.

Results and Discussion

Analysis of polymer type (applicators and wrappers)

FT-IR (diamond ATR) analysis confirmed that all four of the applicators investigated were manufactured from polyethylene (PE) (see Annex 2 for detailed spectra). It is not possible to use FT-IR to distinguish between PE manufactured from fossil-derived carbon and PE manufactured from biological sources of carbon, as the PE itself yields identical FT-IR spectra, irrespective of source. The fate of PE from fossil- and bio-sources, both in the waste stream and in the environment, will also be the same; PE is an environmentally persistent plastic.

Analysis of the disposable outer wrapping of the individual applicators using FT-IR revealed that one of the four was wrapped in PE (Tampax Pearl), while the remaining three were wrapped in polypropylene (PP), which is similarly environmentally persistent. Both PE and PP can, in theory, be recycled, providing these materials can be separated effectively from solid waste streams. Nevertheless, it is unclear what proportion of tampon applicators and the wrapping films in which they are contained will make it to segregated waste recycling, given their association with sanitary products.

Qualitative screening analysis of chemical additives or contaminants (applicators only)

Complex mixtures of extractable chemicals were found to be present in all four of the applicator samples, with the number and diversity of chemicals being quite different in each case (and with a proportion of those compounds in each case not being readily identifiable). Although no priority harmful substances were identified in these screening analyses, given the use of these applicators, it is notable that they contain readily extractable chemicals at all, especially chemicals present as complex mixtures.

These screening analyses do not allow the determination of the concentrations of the chemicals identified, and cannot therefore be used to carry out exposure assessments. Nonetheless, these qualitative results do indicate that the plastics from which the applicators are made also carry a range of chemicals, either as deliberate additives or as contaminants, which warrant further investigation as to their origins and purpose. One possible source for such chemicals is carry over as contaminants from the manufacture and moulding of the plastic, though some may well be there as deliberate additives, perhaps to reduce friction and to stabilise the plastic during storage. Dialogue with the manufacturers of the products, or perhaps even with the upstream manufacturers of the polyethylene that is used in these products, would be an important step towards identifying the sources and determining if they are necessary to the functioning of the product or are instead contaminants that can be avoided in future.

The analyses that we have conducted are, of course, of a limited nature – with time and resources, it would be possible to carry out much deeper forensic analysis of the polymer materials in order to try to identify a higher proportion of the chemicals present, to determine the concentrations of at least some

of those, and to see how the mixtures of chemicals may vary from one part to another of an individual applicator, as well as between different batches of the same tampon brand. What this research does indicate, however, is that such additional investigations should be conducted in order to describe more fully the nature of the disposable polymer materials currently in use in a range of tampon products.

Acknowledgments

Access to the PerkinElmer Frontier FT-IR spectrometer and Spotlight 400 imaging FT-IR microscopy system was made possible under a Research Partnership Agreement between the Greenpeace Research Laboratories and PerkinElmer.

For further information, please contact:

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Appendix 1: Details of methodologies

FT-IR analysis for polymer type

FT-IR analysis was carried out using a PerkinElmer Frontier MIR Spectrometer, using a universal diamond–ATR accessory. Each applicator sample was placed onto the diamond surface (after precleaning the surface with analytical grade ethanol and verifying cleanliness with a preview-scan) and a consistent force applied using the sample clamp.

FT-IR spectra (mid-infrared) were obtained for each sample by scanning in the wave number range between 4000 and 650 cm-1, at a resolution of 4 cm-1, and acquiring a minimum of 16 scans per item. All spectra obtained were processed using PerkinElmer's Spectrum software (version 10.5.4), enabling post-acquisition background subtraction and normalisation of the data and subsequent comparison against a number of commercially available spectral databases, including PerkinElmer's standard Polymers Library, as well as against a custom built database prepared in our own laboratory through analysis of a range of analytical standards of common plastics.

The PerkinElmer FT-IR spectrometer and microscopy system and all accessories and FT-IR spectral libraries used in this study were supplied by and purchased from PerkinElmer under a research partnership agreement with Greenpeace.

Analysis for extractable organic compounds

Preparation

Approximately 2 g cut from the tip of each applicator was extracted into a mixture of pentane and acetone in a ratio of 3:1, using a sonic bath at a temperature of 60^{o}C. Obtained extracts were concentrated to a volume of 3ml with a stream of clean nitrogen and cleaned up prior to analysis. For the clean-up stage, each extract was shaken with 3ml isopropyl alcohol and 3ml TBA-reagent (mixture of 3% tetrabutylammonium hydrogen sulphate and 20% sodium sulphite in deionised water) and left to stand until the aqueous and organic phases had separated. The pentane phase was collected and eluted through a Florisil column, using a 95:5 pentane:toluene mixed eluent, and the cleaned extract concentrated to a final volume of 1ml as before. 20 µg of bromonaphthalene was added to each extract as a second IS prior to GC-MS analysis.

Analysis

For the total organic compounds screening, samples were analysed using an Agilent 6890 Series II GC with Restek Rtx-17Sil column (30m, 0.25mm ID, 0.25 µm film thickness) linked to an Agilent 5973 Inert MSD operated in EI mode and interfaced with an Agilent Enhanced Chem Station data system. The GC oven temperature program employed was as follows: an initial temperature of 40^{0}C, raised to 260^{0}C at 10^{0}C/min, then to 295^{0}C at 50^{0}C/min (held for 5 min), then to 325^{0}C at 50^{0}C /min (held for 4 min), finally raised to 330^{0}C at 50^{0}C/min. The carrier gas was helium, supplied at 1ml/min. Identification of compounds was carried out by matching spectra against both the Wiley 7N and Pesticides Libraries, using expert judgment as necessary in order to avoid misidentifications.

Quality control

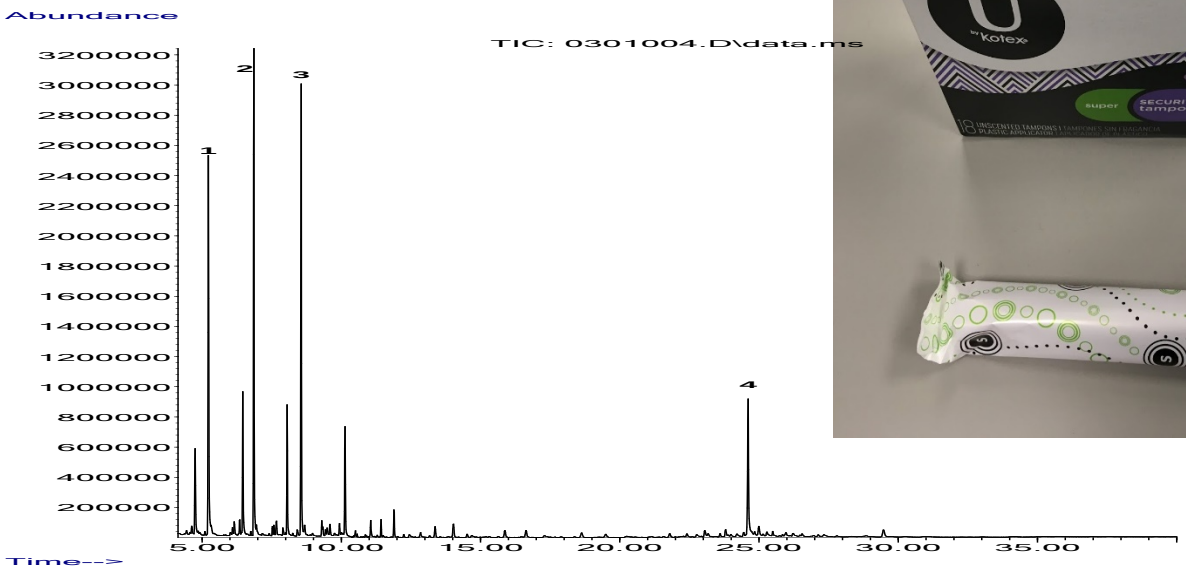
A number of extraction and solvent blanks were also analysed to ensure the detection of any possible contamination resulting from sample handling in the laboratory. Any background contaminants detected in blanks are subtracted from the chromatograms obtained for the samples before mass spectra are interpreted.

Appendix 2: Detailed results from the FT-IR and GC-MS screening analyses

Detailed data arising from FT-IR and GC-MS analysis of each of the samples are presented below. In the case of the GC-MS analyses, only those substances identified to greater than 90% quality match (following verification by expert interpretation) are listed here.

NGP17001: Kotex tampon applicator

GC-MS forensic chemical screening results: plastic tip



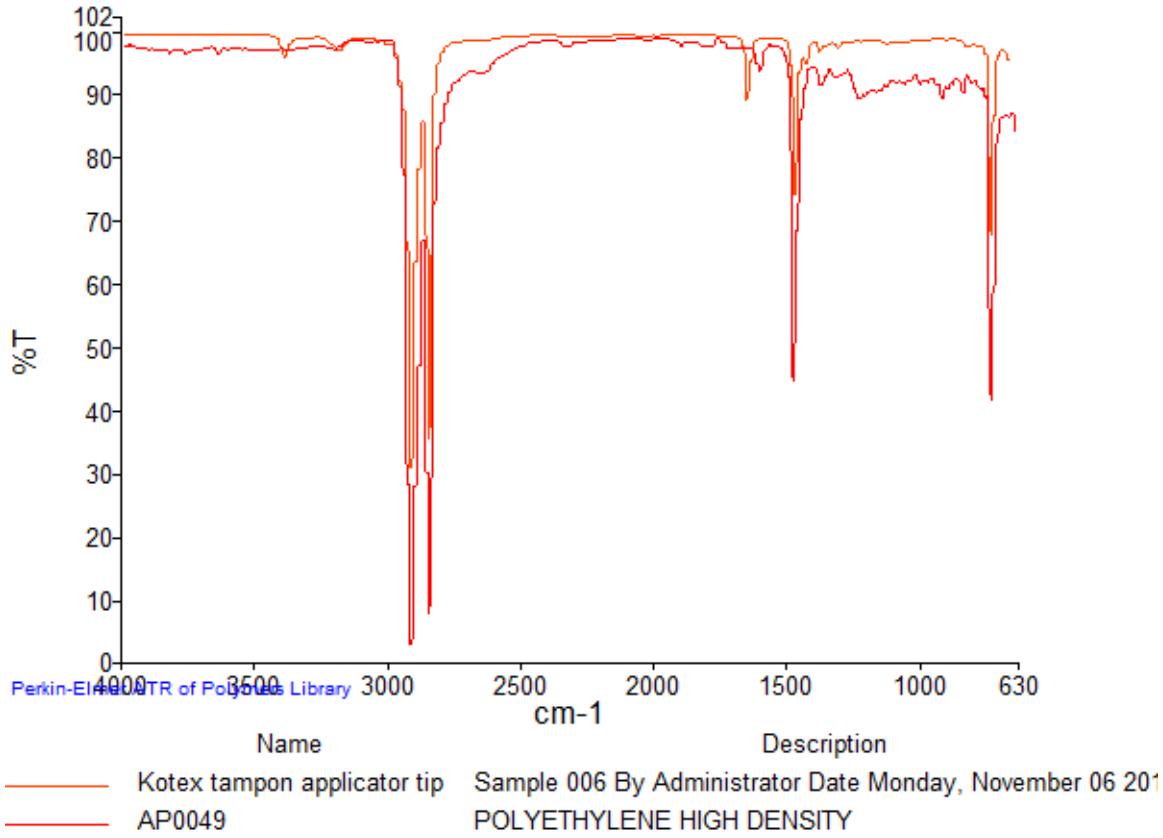
Number of compounds isolated: 42

Compounds identified to better than 90%:

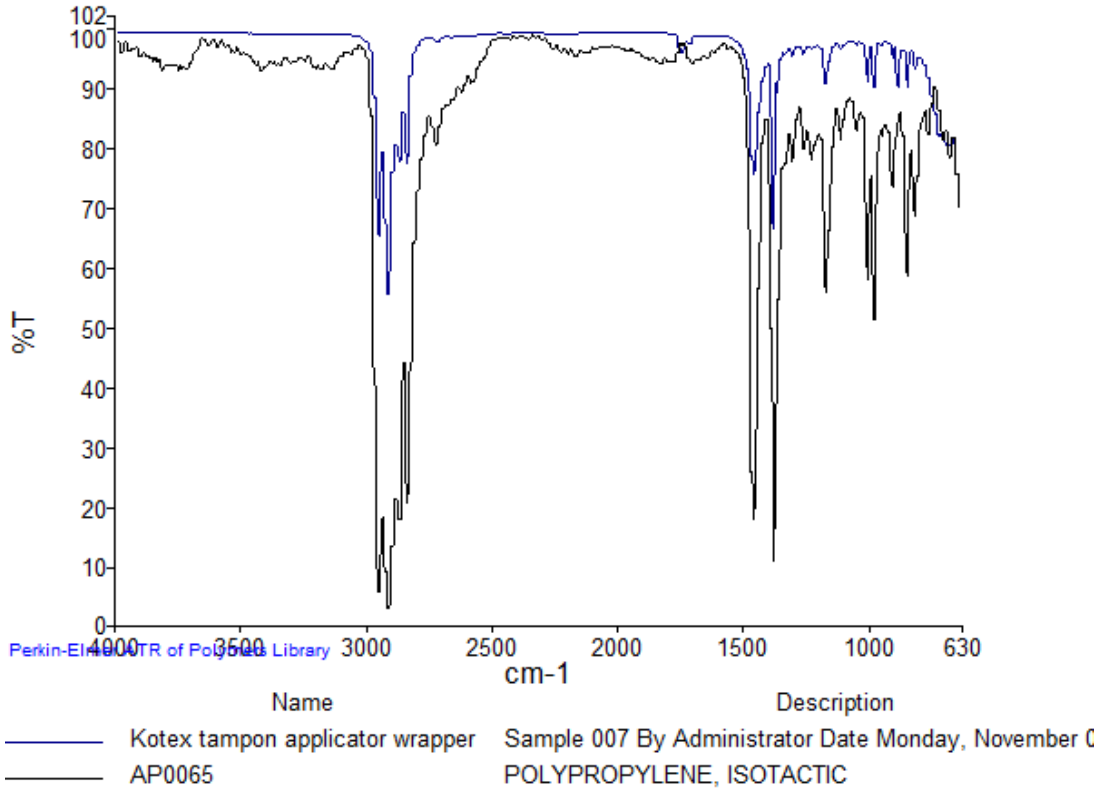
CAS#	Name	
013151-29-6	1-Decene, 4-methyl-	
001120-36-1	1-Tetradecene	
056862-62-5	10-Methylnonadecane	
051655-65-3	2-Butyl-1-decene	
003322-62-1	9-Octadecenamide	4
000629-73-2	Cetene	
000112-40-3	Dodecane	**1**
000112-95-8	Eicosane	
054833-23-7	Eicosane, 10-methyl-	
000630-01-3	Hexacosane	
000544-76-3	Hexadecane	3
000057-10-3	n-Hexadecanoic acid	
000629-59-4	Tetradecane	**2**
000544-63-8	Tetradecanoic acid	
002040-64-4	Tetradecanoic acid, dodecyl ester	
002599-01-1	Tetradecanoic acid, hexadecyl ester	
001632-70-8	Undecane, 5-methyl-	

NGP17001: Kotex tampon applicator

FT-IR analysis of polymer type: plastic tip

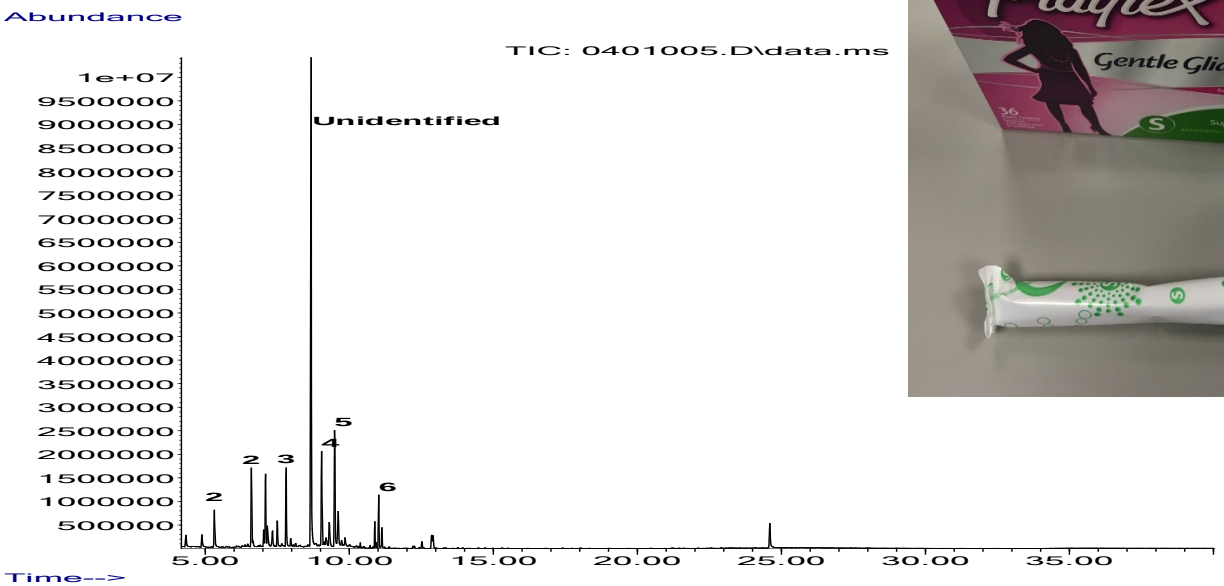


FT-IR analysis of polymer type: wrapper



NGP17002: Playtex tampon applicator

GC-MS forensic chemical screening results: plastic tip



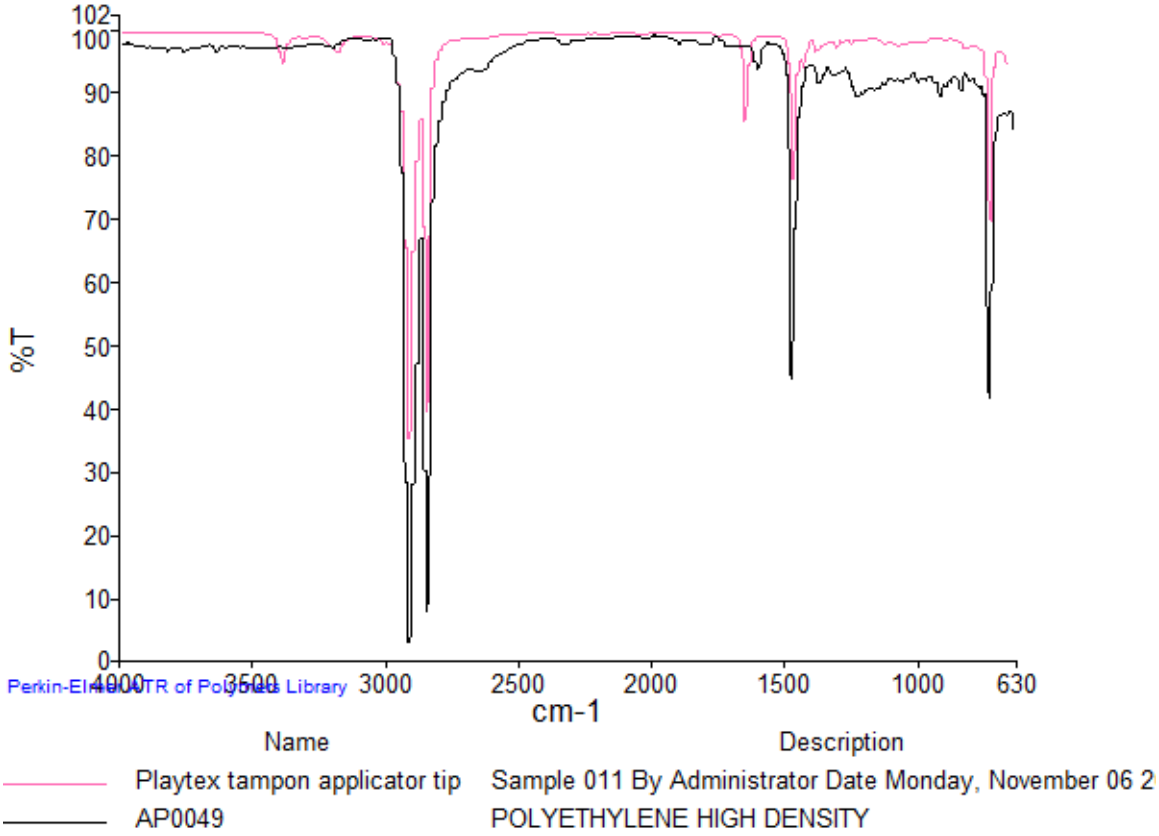
Number of compounds isolated: 48

Compounds identified to better than 90%:

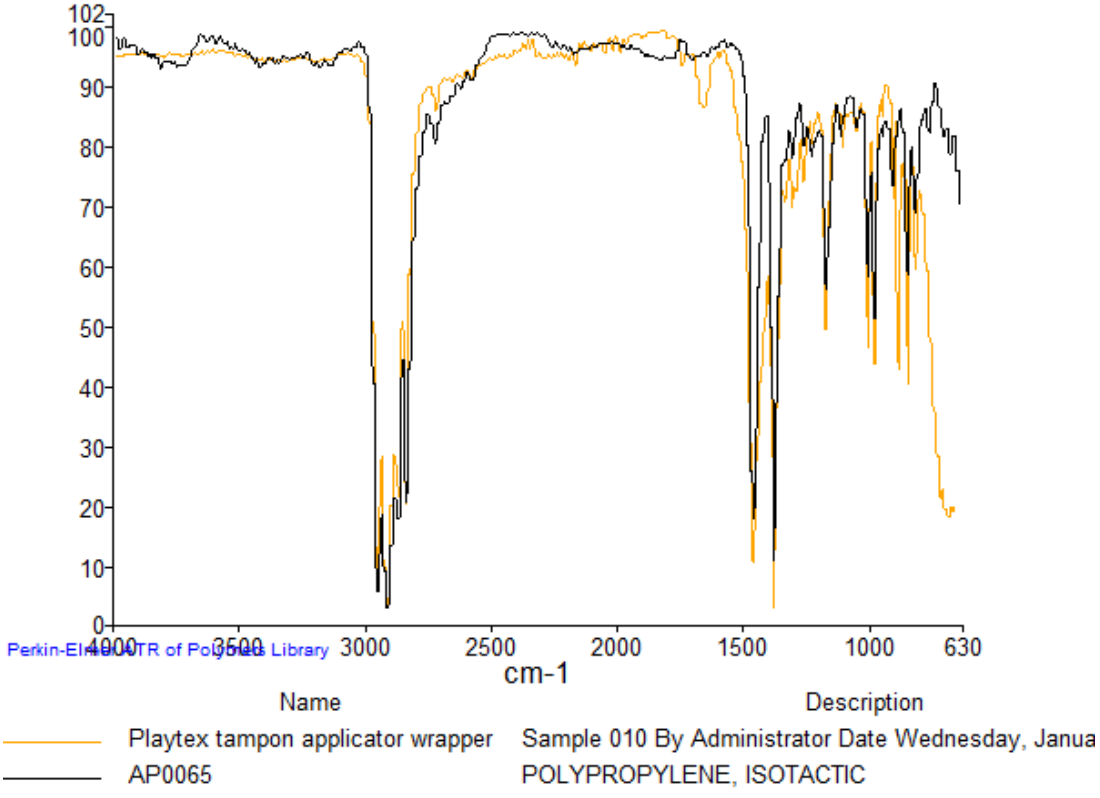
CAS#	Name	
043052-87-5	(-)-.alpha.-Damascone	
000127-42-4	.alpha.-n-methyl Ionone	
014901-07-6	.beta.-Ionone	**5**
000088-29-9	1-(3-Ethyl-5,5,8,8-tetramethyl-5,6,7,8-tetrahydro-2-naphthalenyl)ethanone	
000000-00-0	1-(4-Isopropylphenyl)-2-methylpropyl acetate	
000127-43-5	1-Penten-3-one, 1-(2,6,6-trimethyl-1-cyclohexen-1-yl)-	
000106-25-2	2,6-Octadien-1-ol, 3,7-dimethyl-, (Z)-	
114933-28-7	3-Penten-2-one, 4-(2,6,6-trimethyl-2-cyclohexen-1-yl)-	**4**
001222-05-5	4,6,6,7,8,8-Hexamethyl-1,3,4,6,7,8-hexahydrocyclopenta[g]isochromene	
032210-23-4	4-Tert-butylcyclohexyl acetate	**3**
000301-02-0	9-Octadecenamide, (Z)-	
013674-19-6	Cyclohexanemethanol, 4-(1-methylethyl)-, trans-	
001124-26-1	Cyclohexene, 3-methyl-6-(1-methylethyl)-, trans-	
004727-18-8	Cyclopentadecanone, 2-hydroxy-	
005989-27-5	d-Limonene	
053219-21-9	Dihydromyrcenol	
000544-76-3	Hexadecane	
000000-00-0	Hexamethyl-pyranoindane	
000078-70-6	Linalool	**1**
000115-95-7	Linalyl acetate	**2**
024851-98-7	Methyl (3-oxo-2-pentylcyclopentyl) acetate	
006259-76-3	n-Hexyl salicylate	**6**
000077-83-8	Oxiranecarboxylic acid, 3-methyl-3-phenyl-, ethyl ester	
000629-62-9	Pentadecane	
000629-59-4	Tetradecane	

NGP17002: Playtex tampon applicator

FT-IR analysis of polymer type: plastic tip

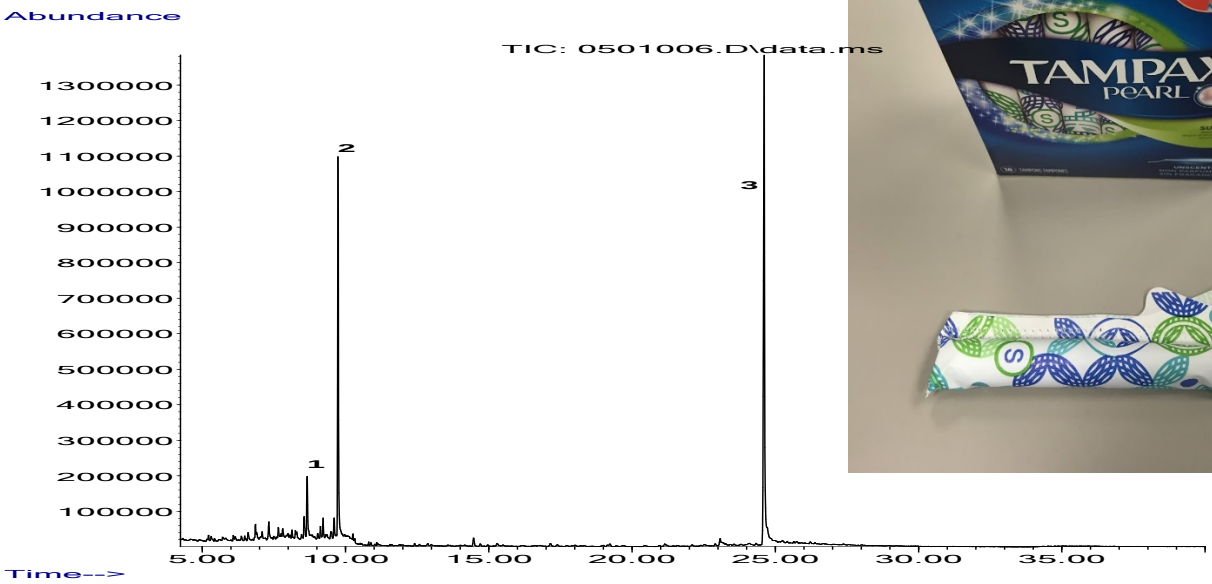


FT-IR analysis of polymer type: wrapper



NGP17003: Tampax tampon applicator

GC-MS forensic chemical screening results: plastic tip



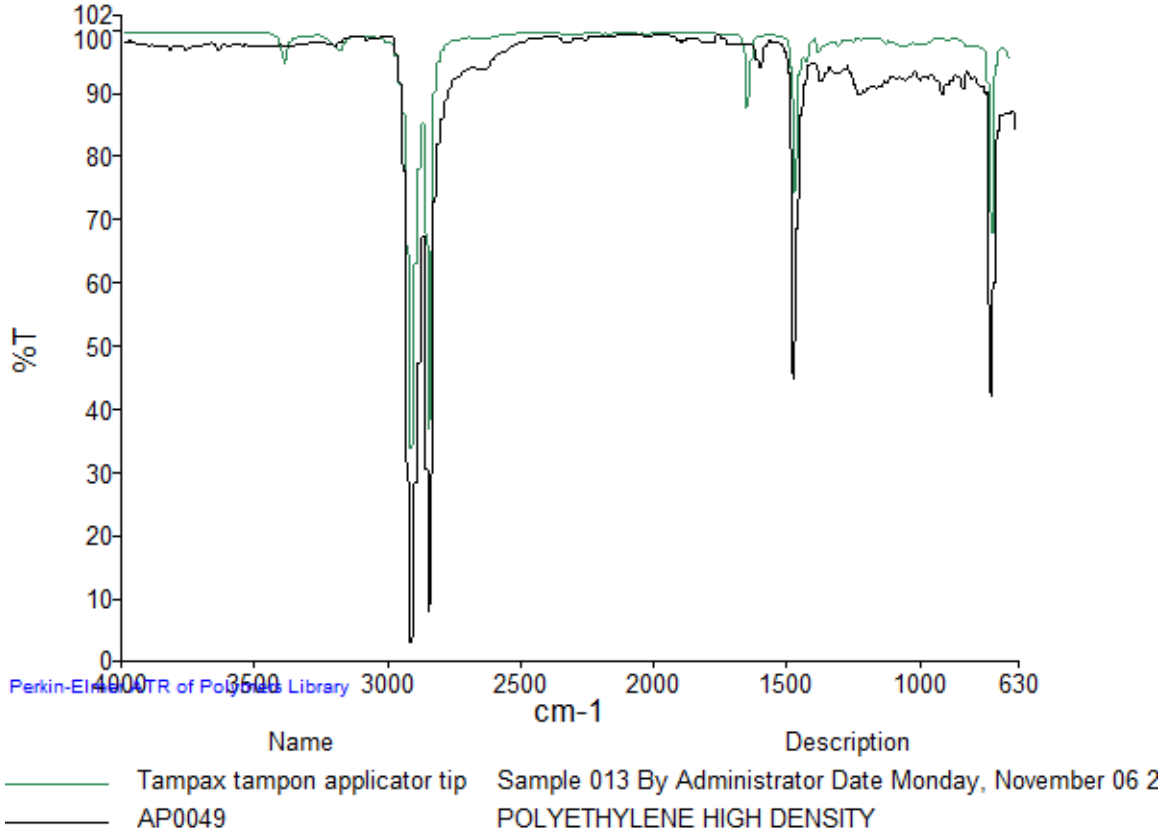
Number of compounds isolated: 25

Compounds identified to better than 90%:

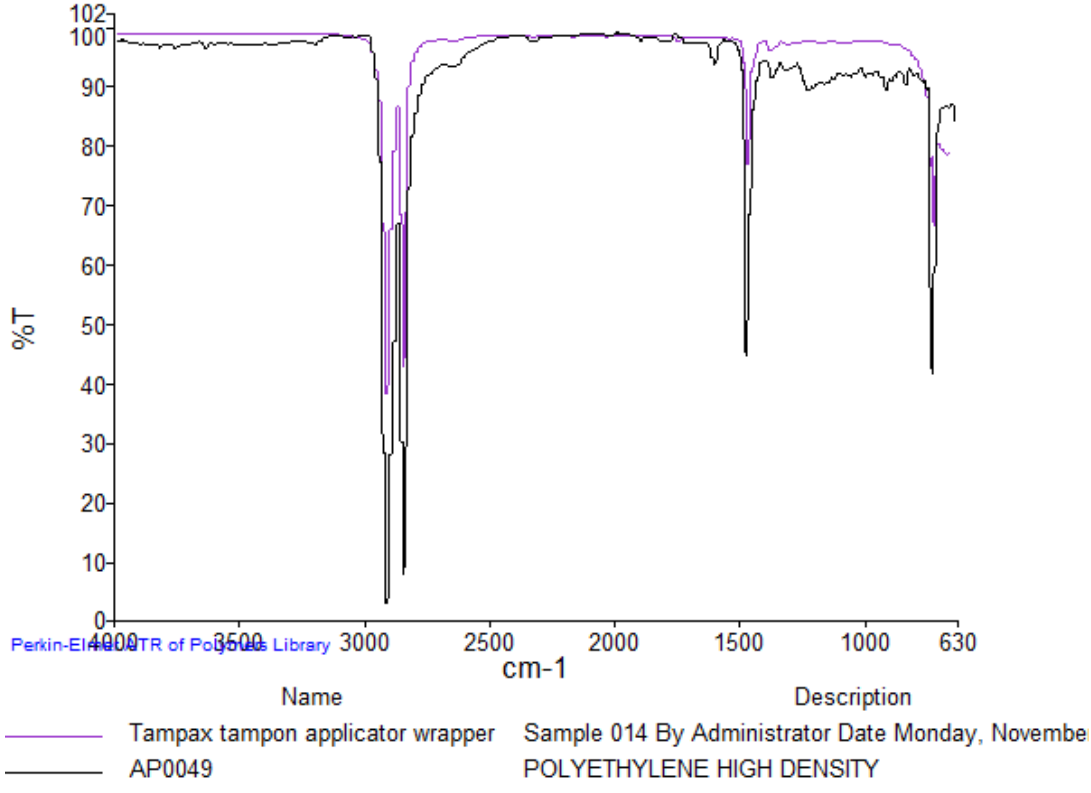
CAS#	Name	
000692-86-4	10-Undecenoic acid, ethyl ester	**1**
000301-02-0	9-Octadecenamide, (Z)-	**3**
000079-77-6	beta.-Ionon	
010233-13-3	Dodecanoic acid, 1-methylethyl ester	**2**
000544-76-3	Hexadecane	
000111-06-8	Hexadecanoic acid, butyl ester	
000629-62-9	Pentadecane	
000629-59-4	Tetradecane	

NGP17003: Tampax tampon applicator

FT-IR analysis of polymer type: plastic tip

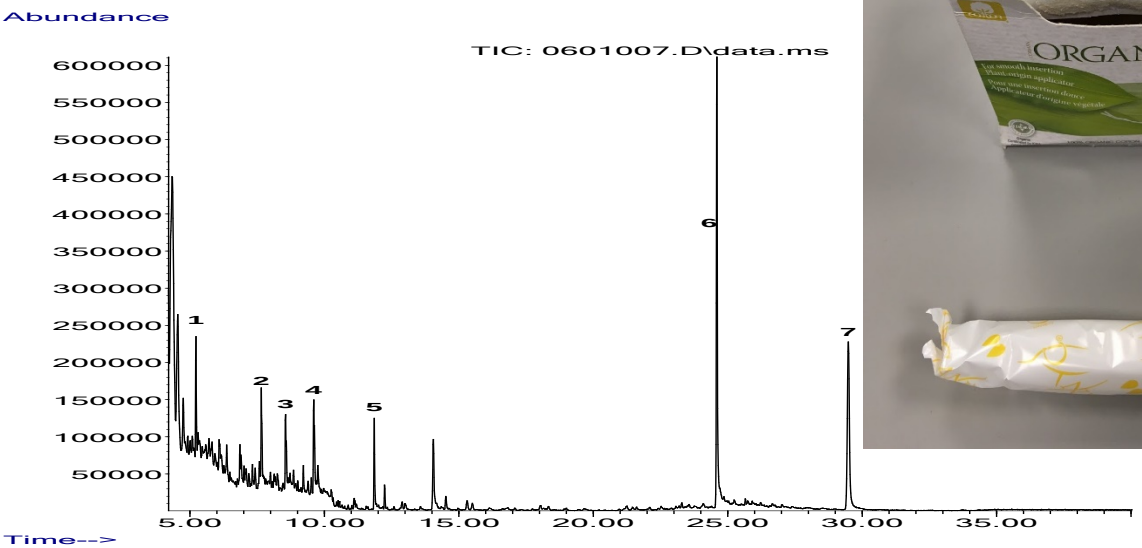


FT-IR analysis of polymer type: wrapper



NGP17004: Organyc tampon applicator

GC-MS forensic chemical screening results: plastic tip



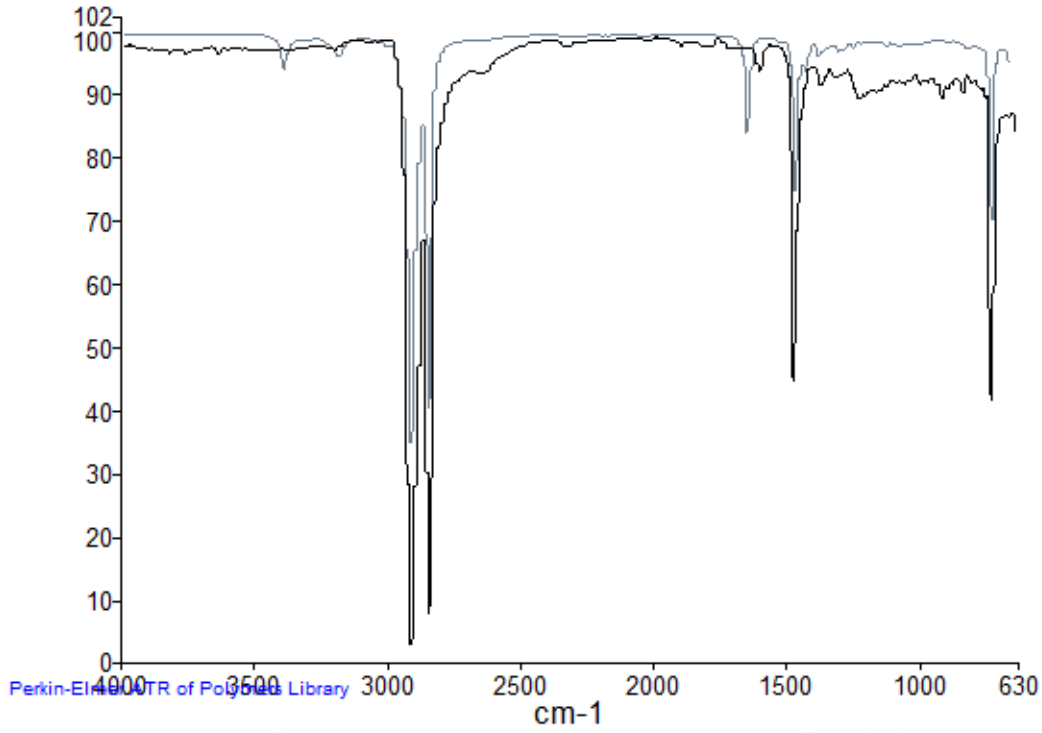
Number of compounds isolated: 22

Compounds identified to better than 90%:

CAS#	Name	
014722-40-8	1,15-Pentadecanediol	
036653-82-4	1-Hexadecanol	**5**
000629-73-2	1-Hexadecene	**4**
000112-92-5	1-Octadecanol	
000301-02-0	9-Octadecenamide, (Z)-	**6**
002082-79-3	Benzenepropanoic acid, 3,5-bis(1,1-dimethylethyl)-4-hydroxy-, octadecyl ester (synonym: Irganox 1076)	**7**
000112-40-3	Dodecane	**1**
000544-76-3	Hexadecane	**3**
000112-39-0	Hexadecanoic acid, methyl ester	
000629-62-9	Pentadecane	**2**
000629-59-4	Tetradecane	

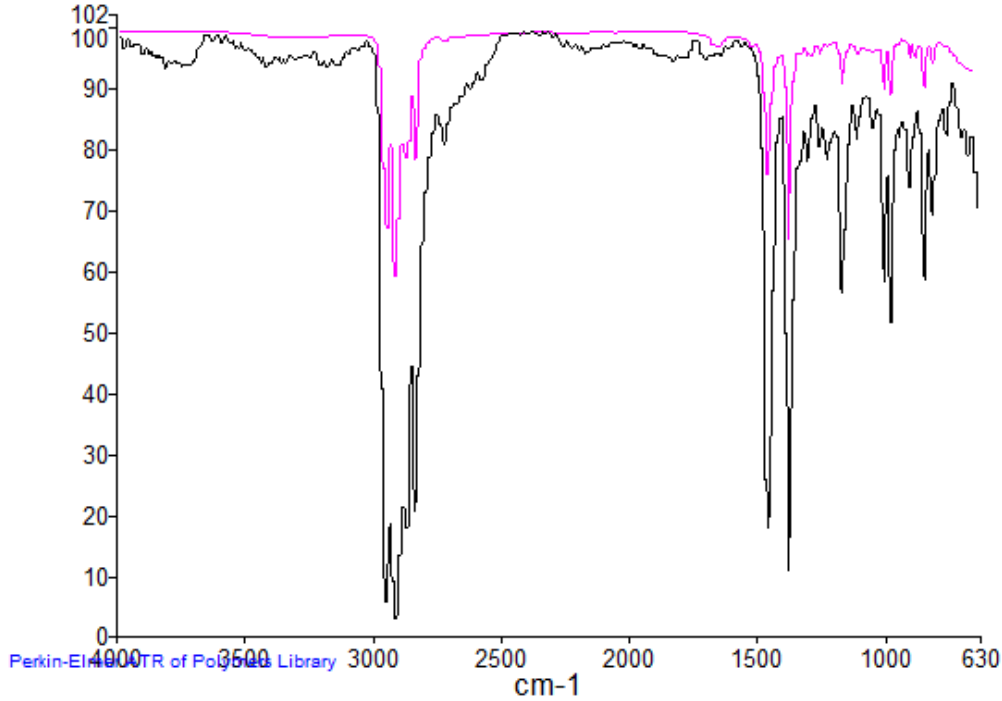
NGP17004: Organyc tampon applicator

FT-IR analysis of polymer type: plastic tip



Name	Description
Organyc tampon applicator tip	Sample 011 By Administrator Date Wednesday, January 17
AP0049	POLYETHYLENE HIGH DENSITY

FT-IR analysis of polymer type: wrapper



Name	Description
Organyc tampon applicator wrapper	Sample 009 By Administrator Date Wednesday, Janu
AP0065	POLYPROPYLENE, ISOTACTIC