

Report: Analysis of residues of health hazardous and carcinogenic substances (PAHs) on contaminated fire protective clothing before and after machine washing with Lejon Kemi's liquid detergent, FPG Wash.



Lejon Kemi

T-1930106/LK Date: 2019-10-14
Updated: 2023-03-30 (3)

Report on residues of PAHs (polycyclic aromatic hydrocarbons) on contaminated fire protective clothing before and after machine washing.

Background

It has been documented that smoke and soot from fires contains many health hazardous substances, including substances that may cause severe diseases such as cancer after repeated exposure for extended periods via, for example, skin contact and inhalation. The awareness of the health risks posed by exposure to soot has, for example, resulted in the need for effective and safe methods for washing and cleaning of fire-fighting clothing (turn out gear) used by fire-fighting personnel.

Many of the health hazardous substances that occur in fire smoke and soot are oil and fat soluble and often also like tar in consistence which makes them difficult to remove by washing from certain types of synthetic textiles used in fire protection clothing (turn out gear) and gloves.

To achieve the best possible result, it is essential that all parameters of importance to cleaning efficacy, such as type and concentration of detergents (chemistry), cleaning temperature, cleaning time, mechanical processing and rinsing are fully optimised without this resulting in damage on the materials used in the fire protective clothing's.

New detergents and methods developed by Lejon Kemi

Since spring 2011, Lejon Kemi has worked with the development of detergents and washing methods for effective and safe removal of health hazardous substances from fire protective clothing (turn out gear), breathing apparatus, breathing masks and other PPE.

The development work has been performed in consultation and collaboration with various PPE dishwasher and washing machine manufacturers, manufacturers of breathing apparatus, firefighting brigades, external analysis laboratories, chemists and other specialists in a wide range of areas. After extensive laboratory work and full-scale tests at various fire stations during several years, Lejon Kemi can offer effective and safe detergents as well as specially designed programmes for PPE dishwashers and washing machines for cleaning of breathing apparatus, breathing masks, turn out gear, fire protective gloves etc.

The new detergents and methods provide excellent cleaning results both visually and according to independent laboratory analyses. The detergents and methods have been developed to be as effective as possible without causing damage to the materials used in fire-protective clothing, breathing apparatus, breathing masks and other PPE.

The detergents and cleaning methods have been thoroughly tested on several brands and models of PPE during long time in laboratory and in full scale at fire stations.

Lejon Kemi's products are marketed under own trademarks via retailers/business partners in Norway, Denmark, Iceland, Slovenia and some other countries. Some of the products are sold by Interspiro AB, (member of the Ocenco Group), under Interspiro's trademarks "Interspiro PPE Decon Cleaner", "Interspiro PPE Decon Detergent", Interspiro PPE Decon Defoamer" and "Interspiro PPE Textile Protector". Interspiro markets and sales the products primarily to firefighting brigades that use Interspiro breathing apparatus.

Purpose of external analysis at independent laboratories of cleaning efficacy

It is not possible visually to see or determine the occurrence of health hazardous substances which can be found on surfaces exposed to fire smoke/fire gases. An impartial accredited laboratory firm was therefore hired by Lejon Kemi to measure the residues of a number of health hazardous substances (polycyclic aromatic hydrocarbons, PAHs) on samples taken from a contaminated fire protective clothing before and after washing. The purpose of the analyses has been to examine the effectiveness of the liquid detergent in removing a number of health hazardous substances, including carcinogenic substances, in addition to visible dirt.

The cleaning process

A contaminated turn-out gear was washed at 60° C during approximately 1 hour 15 minutes in a barrier washing machine with Lejon Kemi's liquid detergent FPG Wash using a washing programme designed for heavily soiled fire protective clothing. Dosage of FPG Wash during the test was 7 ml/1 kg dry clothing for prewash and 18 ml/1 kg dry clothing for main wash. After washing, the turn out gear was fully dried in a drying cabinet at 60° C before sampling. FPG Wash is a water-based mild alkaline detergent developed and optimised for machine washing of breathing mask and turn-out gear.



Photo 1. Laundry room at fire station with washing machine and drying cabinet for emergency suits and breathing masks.



Photo 2. Barrier washing machine in fire station with contaminated zone and clean zone division for handling of, for example, emergency suits and breathing masks.

Methods of sampling and analysis

Samples were taken from a contaminated turn out gear used in connection with a search and rescue fire exercise. The sample comprised all textile layers in the suit, including a water-repellent membrane. After washing and drying of the turn out gear, an identical piece was cut from the suit. After sampling, the samples were placed in clean glass containers, which were sealed. After sample preparation, all samples were analysed with gas chromatography – mass spectrometry.



Photo 4. Picture of washed turn out gear (trousers) from which a sample has been taken for analysis of PAHs.

Choice of substances to be analysed

The 16 substances covered by the analysis are polycyclic aromatic hydrocarbons (PAHs), which are formed in connection with combustion of organic material. 'Polycyclic aromatic hydrocarbons' is a term used for a group of substances consisting of two or more benzene rings.

Light PAH compounds are volatile and primarily occur in gases from fires, whereas more heavy PAHs are non-volatile and bind more easily to air particles such as soot. In turn, the particles may be airborne and deposit themselves on various surfaces, for example, on fire protective clothing, breathing apparatus, gloves, helmets, fire hoses and other equipment used by fire-fighting personnel. This means that PAH exposure may occur in several different ways, through inhalation, skin contact and ingestion.

PAHs consist of a total of approx. 500 substances which are more or less health hazardous, and several types are carcinogenic, for example benza(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, dibenzo(ah)anthracene and indeno(123cd)pyrene. This means that exposure to PAHs may result in an increased risk of cancer and other health problems, especially after extended and/or repeated exposure.

Analysis method

Determination of polycyclic aromatic hydrocarbons, PAHs (16 compounds (substances) according to EPA), in accordance with a method based on US EPA 429 and ISO 11338. The measurements were done with high-resolution gas chromatography and mass spectrometry (GC-MS), which is an analysis method that can measure exceptionally low contents of substances with great accuracy.

Analysis laboratory

The sampling and analyses were performed by ALS Scandinavia AB, box 700, 182 17 Danderyd, Sweden. Website: www.alsglobal.se Email: info.ta@alsglobal.com Phone No.: + 46 (0)8 52 77 52 00. Report, T 1930106 from ALS Scandinavia AB.

Analysis results

The results of the analyses show that residues of the 16 analysed health hazardous and carcinogenic substances (PAHs) decreased significantly after machine washing with the FPG Wash detergent compared with residues of PAHs on the contaminated fire protective clothing. Total level of PAHs was reduced with at least 86,7 % and level of carcinogenic PAHs was reduced by at least 87,9 %.

The residues of several of the individual polycyclic aromatic hydrocarbons on the sample taken from the washed fire protection suit were below the detection threshold for the analysis method (GC-MC). This means that the values for the washed garment may be maximum the stated value, but they may also be lower.

The analysis results show that it is possible to reduce PAHs significantly to exceptionally low levels through machine washing using a washing programme designed for heavily soiled emergency suits at 60° C and using FPG Wash (25 ml/1 kg dry clothing).

Measurement certainty

The measurement security is stated as an expanded uncertainty (according to the definition in "Evaluation of measurement data - Guide to the expression of uncertainty in measurement", JCGM 100:2008 Corrected version 2010) calculated with coverage factor 2, which gives a confidence level of around 95%. The measurement certainty is only stated for detected substances with a value above the reporting threshold. Measurement certainty from sub-supplier is most often stated as an expanded uncertainty calculated with coverage factor 2. For further information, please contact the laboratory. **NB!** This report may only be reproduced in its entirety together unless otherwise approved in writing in advance by Lejon Kemi AB. The results only apply to the identified, received and tested material. Regarding the laboratory's responsibility in connection with the assignment, see the current product catalogue or ALS's website www.alsglobal.se

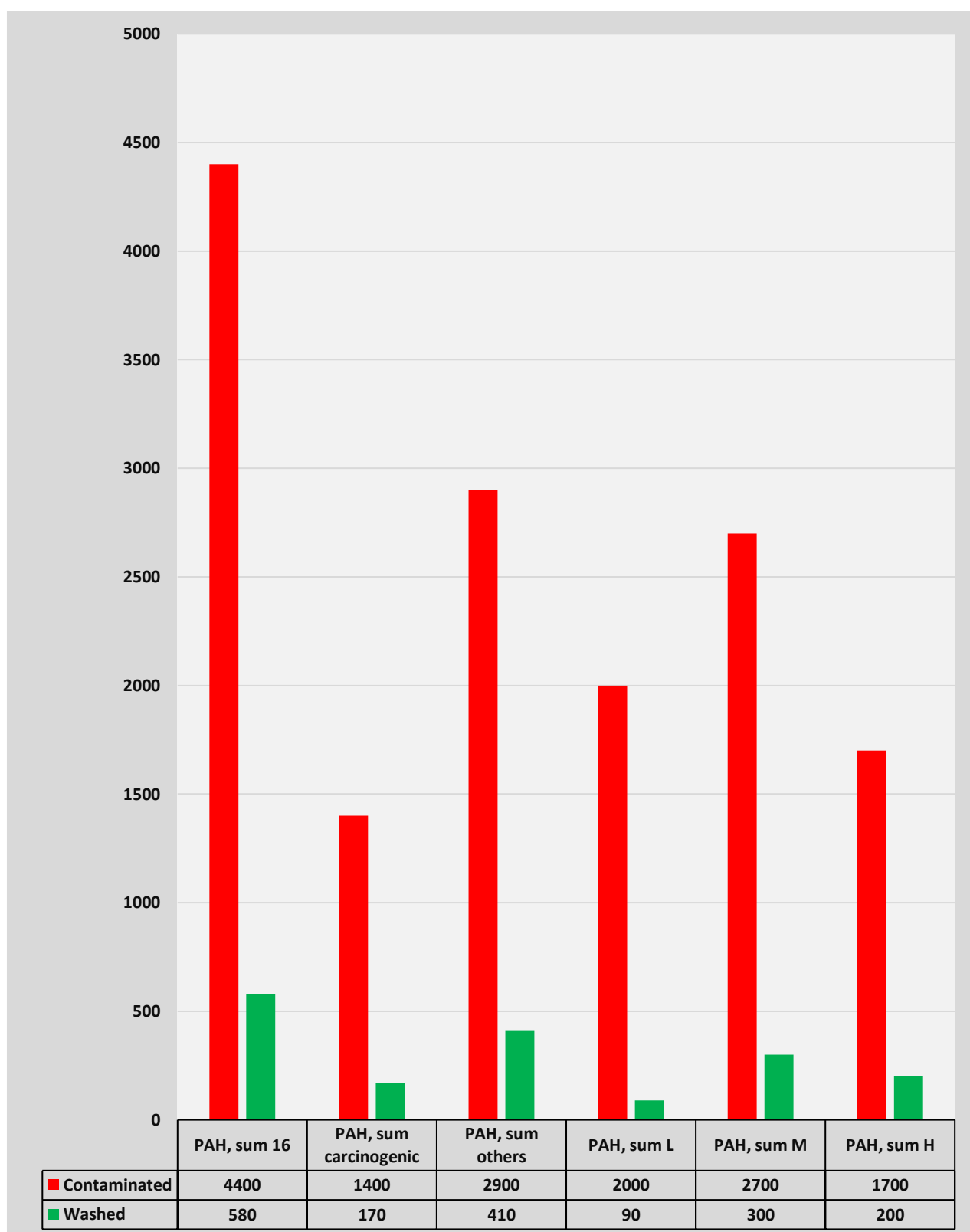


Diagram 1. Total residues in nanogram/gram (ng/g) of health hazardous and carcinogenic polycyclic aromatic hydrocarbons (PAHs) on emergency suit before and after washing. It should be noted that all values for PAH residues after washing may be lower than the values stated in the table. The stated values are the detection threshold for the analysis method. The values must therefore be interpreted as being maximum the values stated, but they may be lower for the washed garment. Total level of PAHs was reduced with at least 86,7 % and level of carcinogenic PAHs was reduced by at least 87,9 %.

Summary

Excellent cleaning results can be achieved when fire protective clothing is washed in washing machines using a FPG Wash detergent developed by Lejon Kemi combined with a specially designed washing programme at 60° C.

The analysis results show that the residues of health hazardous and carcinogenic substances (PAHs) decreased to exceptionally low levels after washing. Total level of PAHs was reduced with at least 86,7 % and level of carcinogenic PAHs was reduced by at least 87,9 %.

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Report no.: ALS T 1930106

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Date: 2019-10-14. (Updated 2023-03-30)