

## An Investigation of PCDD/F Formation during Textile Production and Finishing

**Horstmann, M. , McLachlan, M.S. , Reissinger, M. , Morgenroth, M.<sup>1</sup>**

Chair of Ecological Chemistry and Geochemistry, University of Bayreuth,  
95440 Bayreuth, Germany

<sup>1</sup>College of Textile Engineering, 95213 Münchberg, Germany

### Abstract

Several samples of raw cotton cloth and five different synthetics were analysed for PCDD/F. Cotton cloth was also subjected to a series of textile finishing processes, and samples of the cloth were collected at various stages of the treatment and analysed for PCDD/F. The concentrations were very low in all samples. The maximum  $\Sigma$ PCDD/F measured was 100 pg/g. The contribution of the textile production and finishing to the PCDD/F level in the cloth was negligible compared to the PCDD/F accumulated in clothing when it is worn.

### Introduction

During an investigation of the sources of polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/F) in sewage sludge we discovered significant levels of these compounds in washing machine effluent<sup>1</sup>. This contamination was traced to the laundry. One possible explanation for the PCDD/F levels in laundry could be contamination of the textile fibres during production and finishing. The purpose of this study was to investigate this hypothesis.

Some 125,000 tonnes of over 500 different chemical products are used annually in Germany to finish textiles<sup>2</sup>. An investigation of all compounds and processes was clearly not possible. The results from the washing machine effluents had indicated that the PCDD/F contamination of clothing was widespread. As a result it was decided to focus on two questions:

- 1) What are the PCDD/F levels in different untreated synthetic and cotton fibres?
- 2) What are the PCDD/F levels arising from different processes typically employed in the finishing of cotton?

Cotton is the most important fibre in Germany, accounting for about 50% of all fibres present in textiles.

# FORM

## Experimental Methods

Seven different raw (unfinished) cotton cloths containing fibre from different countries were obtained from a cotton mill. Five different white synthetic materials (acetate, viscose, bleached polyester, polyamide, polyacrylic) were purchased in material stores. These 12 samples were analysed for PCDD/F using the method described below.

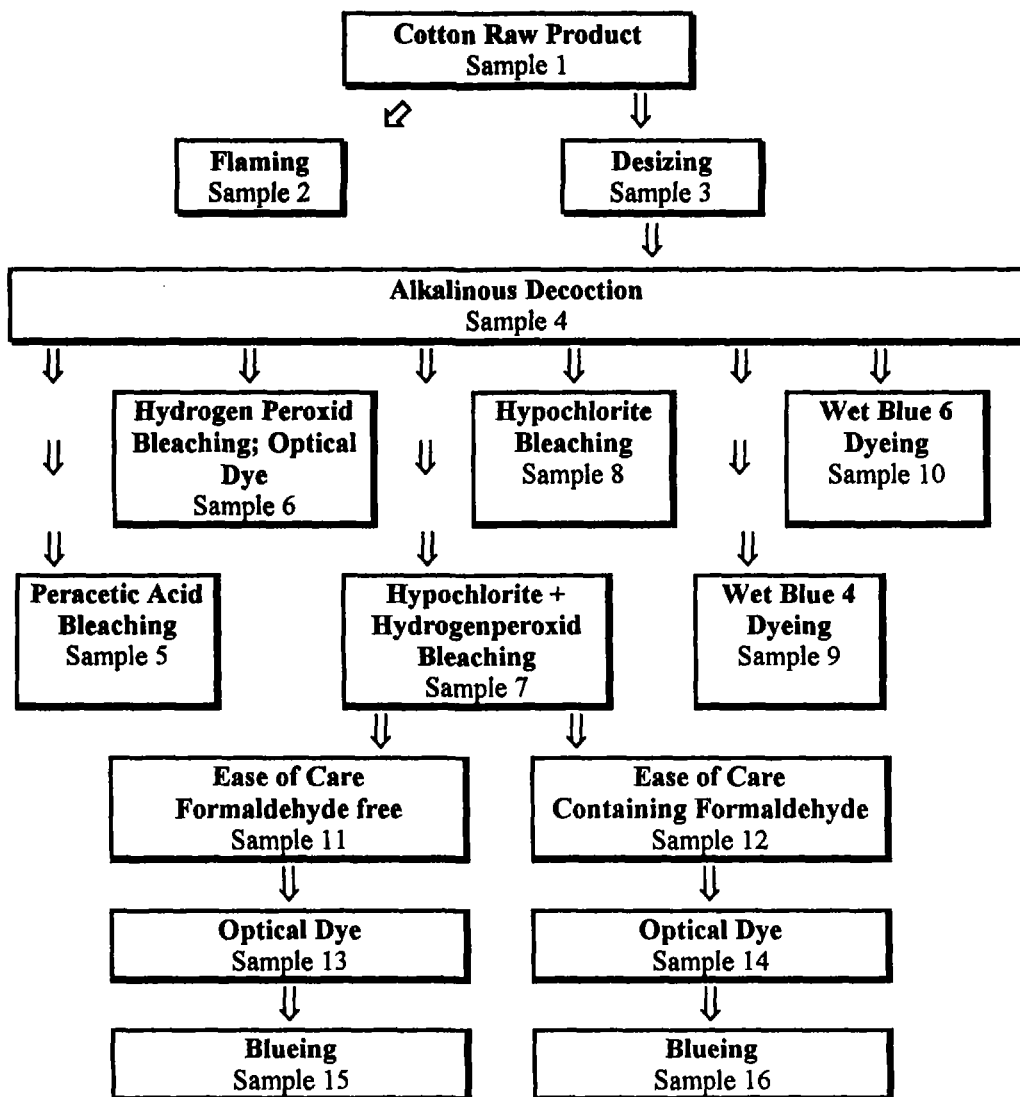


Figure 1: Cotton Finishing Scheme (with Sample Numbers)

One of the cotton materials analysed above was subsequently subjected to a series of typical cotton finishing processes. A sample of the material was analysed after each finishing step. The cotton finishing schematic and the sample numbers are illustrated in Figure 1.

The textile samples were Soxhlet extracted in toluene for 16 hours. The samples were cleaned up according to a previously published method<sup>3</sup>. The HRGC/HRMS analysis was performed on a HP5890 gas chromatograph coupled with a VG autospec ultima mass spectrometer at a resolution of 10,000.

## Results

The  $\Sigma$ PCDD/F for the 7 raw cotton and 5 synthetic cloth samples are plotted in Figure 2. The results are in all cases exceedingly low.

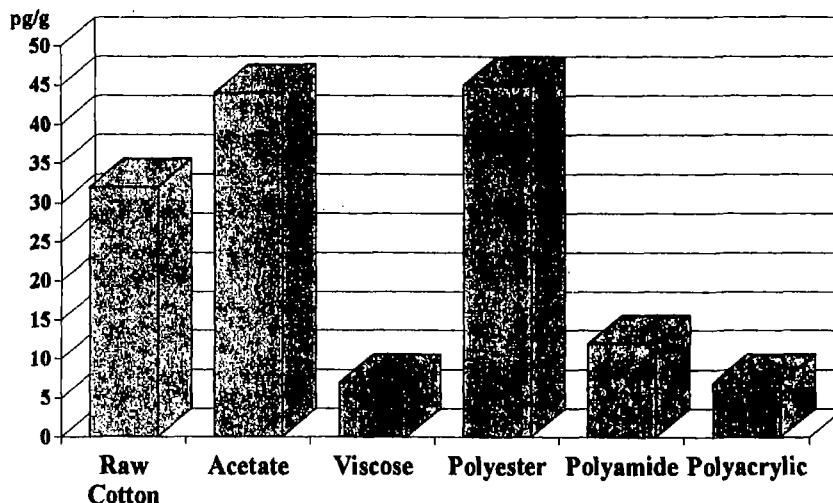


Figure 2:  $\Sigma$ PCDD/F concentrations in 7 raw cotton samples (maximum value) and 5 synthetic cloth samples

In Figure 3 the  $\Sigma$ PCDD/F are plotted for the 16 cotton samples that were collected following the various finishing processes. The concentrations increase during the treatment. This increase is primarily attributable to an increase in Cl<sub>2</sub>DD. Two treatment processes are especially associated with this increase: the application of the indanthrene dye (samples 9 and 10), and the wash and wear finishing process, both with and without formaldehyde (samples 11 and 12, indirectly samples 13-16).

# FORM

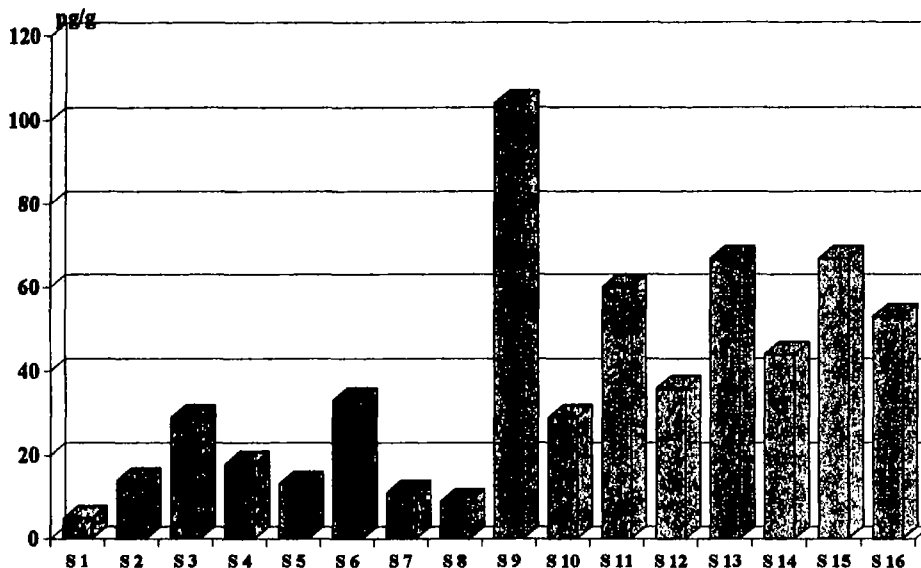


Figure 3:  $\Sigma$ PCDD/F-concentrations in sample material from each finishing step (S=Sample number; see Figure 1)

## Discussion

The low concentrations observed in this study led us to look for other sources of PCDD/F in laundry. It was found that wearing clothing resulted in an increase in the  $\Sigma$ PCDD/F of several orders of magnitude, giving concentrations of several hundred  $\mu\text{g/g}$ <sup>4</sup>. The concentrations found in this study are thus negligible compared to the levels of PCDD/F accumulated in clothing during wearing.

## References

- 1 Horstmann M, McLachlan M S, Reissinger M. Investigations of the Origin of PCDD/F in Municipal Sewage Sludge. *Chemosphere* in press
- 2 Töpfer P, Kaps U, Kopp M, Richter K. Quantitative Untersuchung zur Erfassung der Umweltexpositionen im Bereich der in der Textilveredelung eingesetzten Chemikalien. UBA 106 02 061, Berlin
- 3 Horstmann M, Kaune A, McLachlan M S, Reissinger M, Hützing O. Temporal Variability of PCDD/F Concentrations in Sewage Sludge; *Chemosphere* 1992;25:1463-1468
- 4 Horstmann M, McLachlan M S, Reissinger M. Further Investigations of the Sources of PCDD/F in Municipal Sewage Sludge. See Abstracts of Dioxin'93, Vienna