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A STUDY OF DRY CLEANING SOLVENTS AND CLOTHING: SOURCE OF DIOXIN EXPOSURE?

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Introduction

Both the government and private researchers around the world have used dioxin contaminations in the air, water, soil and foods for assessing the amount of daily dioxin exposure to human beings. However, not many of the dioxin studies focused on clothes or other fabrics as a possible source for dioxin contamination and exposure. However, the data presented in this paper indicate that fabrics should be considered as one of sources of dioxin exposure. A study by the University of Bayreuth, Germany, showed that the sludge residues of the dry-cleaning solvent distillation were contaminated with dioxins.¹ CWWI and ISWC began to research on possible dioxin contaminants in the dry-cleaning related industries since 1997. CWWI and ISWC contacted and requested the analysis of dioxin amount in sample materials at several qualified dioxin-measurement/research institutes², designated by Japanese government. This paper is about the findings resulted from the analysis.

Methods and Materials

Methods: Gas chromatograph method was applied for fabric dioxin analysis. The analysis was applied according to the Dioxin Analysis Manual for Residues presented by Ministry of Environment Japan (Water Pollution and Prevention Division, July 1998). PCDDs and PCDFs were measured for fabric dioxin analysis, but Coplanar PCBs were not, because Coplanar PCBs were not officially considered as dioxins in Japan until July 1999. International Toxicity Equivalency Factor (I-TEF) and World Health Organization Toxicity Equivalency Factor 1997 (WHO-TEF) were used for calculating Toxicity Equivalency Quantity (TEQ) in the sample materials.

Materials: CWWI purchased the brand-new clothes samples from various stores in Japan between the years 1997 and 2000 and sent the clothes to the institutes for analysis. As for the dry-cleaned clothes samples, CWWI purchased brand-new clothes and brought them to several dry cleaners to be dry-cleaned. CWWI pick them up after the dry-cleaning and sent them to the institutes for analysis. For the dry-cleaning solvent samples, ISWC mixed together dry-cleaning solvents and CWWI sent them to the institutes. (At the dry cleaners, several types of dry-cleaning solvents are normally mixed together for better results.)

Results and Discussion

Results

Dry-cleaning solvents Samples: 3 types of brand-new solvents and 1 type of petrol-based solvent that is currently in use were analyzed. The brand-new perc-based solvent³ measured 7.8 pg WHO-TEQ/l of dioxin concentration. The brand-new petrol-based solvent⁴ measured 7.3 pg WHO-TEQ/l

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of dioxin concentration. The brand-new stain-remover (spot cleaning) solvent measured 76 pg-TEQ/l of dioxin concentration. The currently in use petrol-based solvent measured 780.0 pg-TEQ/l of dioxin concentration⁵. (Table1)

Table 1 Analysis of dioxins in dry-cleaning solvents

| CDD/PCDF/ Coplanar PCBs | unit | Types of dry-cleaning solvents | | | |
|----------------------------|----------|--------------------------------|----------------------------------|--------------------------------|------------------------------|
| | | Perc-based solvent (new) | Petrol-based solvent (new) | Spot cleaning solvent (new) | Parc-based solvent (used) |
| PCDDs | ng/liter | 1.4 | 1.3 | 2.0 | 20 |
| PCDFs | ng/liter | 2.8 | 3.4 | 3.8 | 55 |
| PCDDs+PCDFs | ng/liter | 4.2 | 4.7 | 5.8 | 75 |
| PCDDs/DFs TEQ | pg TEQ/l | 7.2 | 6.8 | 75 | 270 |
| Coplanar PCB TEQ | pg TEQ/l | 0.55 | 0.47 | 1.3 | 510 |
| Total TEQ | pg TEQ/l | 7.8 | 7.3 | 76 | 780 |

TEF: WHO-TEF (WHO/PCPS 1998)

TEQ: 2,3,7,8 TeCDD (pg-TEQ/liter)

Table 2: Brand-new Fabrics; Actual value of dioxin concentration and TEQ (pg I-TEQ/g)

| Samples | PCDDs/PCDFs | | | |
|-----------------------|-------------|-------|-------------|--------|
| | PCDDs | PCDFs | PCDDs+PCDFs | I-TEQ |
| Suit 1 (Black) | 164.4 | 120.6 | 285 | 4.4 |
| Suit 2 (Black) | 268 | 154.8 | 420 | 8.5 |
| Suit 3 (Black) | 281.2 | 179 | 460 | 9.3 |
| Suit 4 (Black) | 141.6 | 514 | 660 | 13 * |
| Suit 5 (Black) | 250 | 450 | 700 | 19 * |
| Suit 6 (Blue) | 171.5 | 50.7 | 220 | 2.0 |
| Suit 7 (Blue) | 45.4 | 95 | 140 | 3.1 |
| Suit 8 (Grey) | 65.2 | 57.2 | 120 | 1.8 |
| Suit 9 (Red) | 42.6 | 34.7 | 77 | 0.82 |
| Windbreaker (Grey) | 50.2 | 49.2 | 99 | 1.5 |
| Underwear 1 (Black) | 26.96 | 31.1 | 58 | 1.4 |
| Underwear 2 (Black) | 164 | 60.7 | 220 | 2.8 |
| Jersey knit (Black) | 166.1 | 474 | 640 | 20 |
| Kimono (Black) | 23.73 | 5.69 | 29 | 0.28 |
| Futon (Blue) | 15.9 | 12.14 | 28 | 0.38 |
| Jeans (Blue) | 2.93 | 8.42 | 11 | 0.36 |
| Uniform (Blue) | 17.4 | 75.7 | 93 | 1.0 |
| Sports wear (Blue) | 3.82 | 15.2 | 19 | 0.11 |
| Curtain (Blue) | 7.18 | 5.24 | 12 | 0.073 |
| Sweater (Purple) | 4.08 | 2.98 | 7.1 | 0.034 |
| Skirt (Purple) | 60.5 | 19.2 | 80 | 0.85 |
| Pants (Grey) | 12.59 | 8.77 | 21 | 0.13 |
| Blanket (Beige) | 1.28 | 1.28 | 2.6 | 0.0055 |
| Smock (White) | 2.82 | 2.86 | 5.7 | 0.020 |
| Sheet (White) | 4.156 | 0.68 | 4.8 | 0.0075 |

TEF: International-TEF

TEQ: 2,3,7,8 TeCDD (pg-TEQ/g)

* : includes Coplanar PCBs TEQ

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that the dry-cleaning process adds dioxins on clothes.

Conclusion and Perspective

Dry-cleaning solvents and brand-new as well as dry-cleaned clothes are contaminated with dioxins. The dry-cleaning solvents that CWWI analyzed, could be the sources of dry-cleaning related dioxin contamination. Dye factory could be a source of fabric dioxin contamination. It is possible that fabrics are contaminated with dioxins first in the process of dyeing and then with additional dioxins in the dry-cleaning process. Dry-cleaning solvents are distilled, and the distillation extracts dioxins in the solvents. There are filters in the dry-cleaning machine, but fabrics could play the role of filters and catch dioxins. (The clothes are cleaned in a dry-cleaning washer which has 200liter solvent that contains, we calculate, appropriately 156,000 pg I-TEQ dioxins.)

This study can be important for the dioxin inventory, because we could conclude that the dioxin emission from the wastewater of dye industry is more than the emission of aluminum industry. The assessment of total daily exposure of dioxins needs to consider the exposure from clothes and other fabrics both brand-new and dry-cleaned. In addition, the assessment needs further studies for dioxin absorption through skins.

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References

- ¹ Fuchs, Towara, Hutzinger et al. PCDD/F in Dry-Cleaning Process. Universitat Bayreuth, FRG. Organohalogen Compounds 3. 44 | 1991.
- ² Japan Quality Assurance Organization, Tokyo/ Joetsu Environmental Science Center, Niigata/ The Chiba Pharmaceutical Association Research Center, Chiba/ Shizuoka Industrial Environment Center, Shizuoka/ Shimazu Techno Research, Nagoya/ Nippon Total Science, Hiroshima/ Field Science, Sapporo/ Environmental Research Institute, Tokyo/ Maxxam Analytics Inc., Canada/ Seika Corp., Tokyo/ Chugai Technos, Environmental Tech Center/ Gesellschaft fur Arbeitsplatz und Umweltanalytik mbH, Germany
- ³ Combination of Perchloroethylene, dry-cleaning soap and sizing (P-480)
- ⁴ Combination of Trichlorotrifluoroethane, dry-cleaning soap and sizing (TBF-N)
- ⁵ Only petrol-based solvent was analyzed as used solvent.
- ⁶ The same pants are dry washed at different cleaners.