

Analysis of filter dusts from aluminum recycling processes and interpretation of the results by Multivariate Data Analysis (MVDA)

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ABSTRACT

Levels of polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/PCDF) were determined in filter dusts and slugs from an aluminum recycling plant. De-novo-synthesis was postulated as a possible way of PCDD/PCDF formation, which was confirmed by MVDA. The samples were assigned to ascertain formation conditions.

INTRODUCTION

Metal reclamation processes are known to be an important source of pollutant emission. Especially in recycling processes a considerable environmental pollution occurs due to the release of partially newly formed highly toxic organohalogen compounds like PCDD, PCDF and others.

Secondary aluminum is predominantly produced in rotating cylinder furnaces, where aluminous scraps are molten covered by a salt layer. The type of the burner and the undesirable stickings on the basic material, such as food, paint or fat residues and other packaging material, are essentially for the formation of pollutants.

The detected concentrations of PCDD/PCDF were interpreted by MVDA with regard to their formation conditions. For that purpose comparative data from literature considering the de-novo-synthesis of PCDD/PCDF was used 1-12.

EXPERIMENTS

The samples taken at the aluminum recycling plant Rackwitz (Germany) are airborne dusts and slugs from the so-called "Fuchsansatz" (approximate temperature 800°C), from the channel (approximate temperature 400°C) and from a flue gas cleaning device (approx. temperature 100-200°C).

FORM

CLEAN-UP:

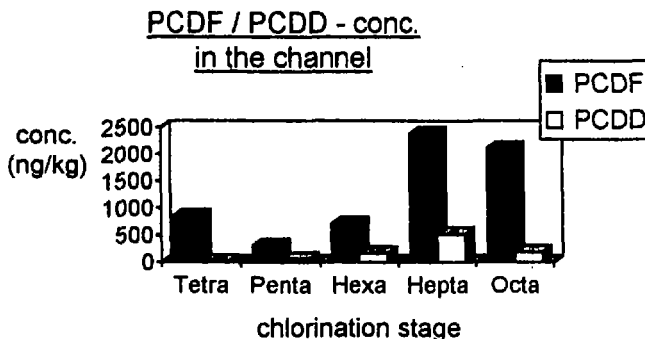
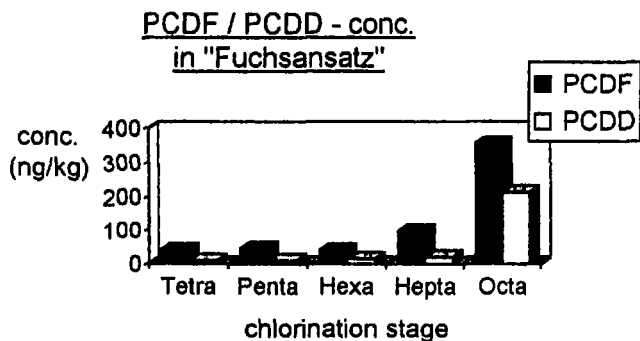
For PCDD/PCDF analysis, the samples were extracted with toluene for 30 hours and then subjected to a series of column chromatography steps including florisil, acid silica and activated charcoal.

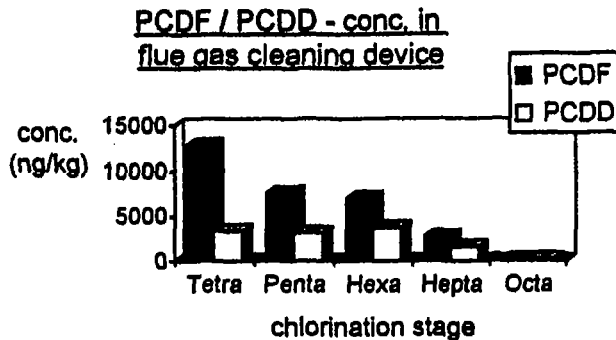
MEASUREMENTS:

Measurements were carried out by GC/MS(SIR) - analysis (HP 5890 coupled with ZAB - HSQ (VG-Analytical)). CP Sil 8 CB (25m x 0.32mm i.d.) was used as capillary column. The quantification was carried out with an external standard, that contained the so-called "toxic" isomers.

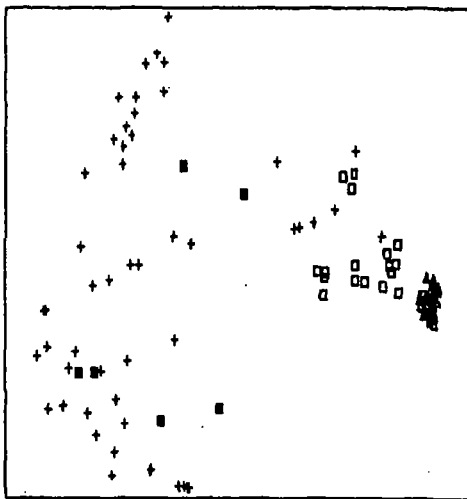
RESULTS AND DISCUSSION

The detected concentrations range from 6,2 TE ppt (BGA) ("Fuchsansatz") to 1820 TE ppt (flue gas cleaning device). Regarding the homologue pattern the analysed samples show great differences: in the "Fuchsansatz" hepta- and octachlorinated dibenzofurans predominate, while in dusts from the flue gas cleaning device mainly tetra- and pentachlorinated dibenzofurans were detected.

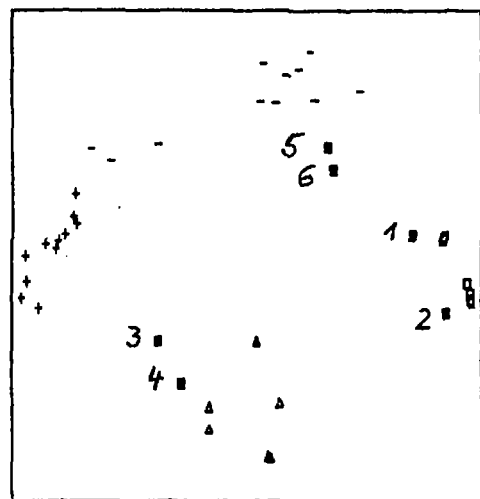




Based on these differences the samples can be assigned to certain formation conditions. The data were interpreted based on the programm "PEDAS" by Kurt Varmuza¹³. Principal component analysis (PCA) was carried out on the basis of the sums of PCDD/PCDF homologues at each chlorination stage.



-129.81 PC-SCORE u1 var:56.1% 74.40



-119.33 PC-SCORE u1 var:60.1% 56.12

Fig. 1
Samples assigned to de-novo-synthesis

- samples with pattern of combustion
- △ samples with "chemical" pattern (e.g. PCP)
- + samples of de-novo-synthesis
- unknown samples

Fig. 2
Samples assigned to certain formation conditions

- decomposition conditions (high temperature)
- △ mild composition conditions
- + good composition conditions
- good composition conditions (different homologue pattern)
- unknown samples
- no. 1 + 2 "Fuchsansatz"
- no. 3 + 4 channel
- no. 5 + 6 flue gas cleaning device

FORM

As shown in Figures 1 and 2, the samples can be assigned to de-novo-synthesis (fig. 1) and to certain formation conditions (fig. 2):

- samples from "Fuchsansatz": decomposition conditions at high temperatures leading to low concentrations
- samples from the channel: mild composition conditions leading to medium concentrations
- samples from the flue gas cleaning device: good composition conditions and accordingly high concentrations.

These results confirm the expectations concerning the thermal conditions of the process.

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