

## Technical Plastics as PCDD/F Absorbers

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### 1. Introduction

Various plastics commonly used as coating materials in wet scrubbing systems of waste incineration plants were studied and found to absorb PCDD/F<sup>1)</sup>. The variations of the PCDD/F emissions observed when the wet scrubbing system was passed by the flue gas could be explained by the strong temperature dependence of the absorption/desorption equilibrium.

On the basis of these results, experiments were performed aiming for utilisation this in normal operation undesired effect for selective separation of PCDD/F from the exhaust gas. Within the framework of our studies, the best suitable plastic was determined for this purpose.

### 2. Experimentals

#### a) Test series 1

Using the experimental setup represented in Fig. 1a, the PCDD/F absorption behavior of four plastics (polypropylene PP, polyethylene PE, polyvinylidifluorid PVDF and polytetrafluoroethylene PTFE) was studied. The plastics were applied in the form of chips (about

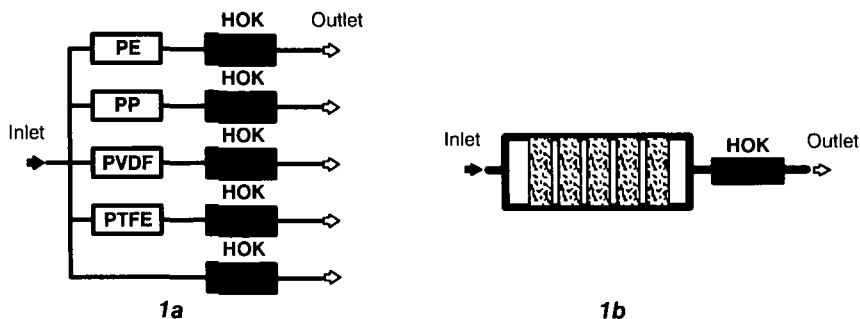


Fig. 1: Experimental setup

10x10x1mm) and inserted into a glass tube as a fixed bed. For the experiments a bed depth of 10 cm was selected. The fixed beds were exposed to flue gas taken from a waste incineration plant downstream of the fabric filter at a face flow velocity of 0.1 m/s. To investigate the

dependence, the tests were performed at 60, 80 and 100 °C, respectively. The gas flowing through the fixed beds was then passed through glass cartridges filled with carbonized lignite (HOK)<sup>2</sup>. In parallel, one HOK cartridge was used for control purposes and passed directly by the exhaust gas flow. All plastics and HOK samples were analyzed.

## b) Test series 2

In these experiments, PP and PE were applied in the form of pressed, circular disks (sintered parts,  $d_p = 100 \mu\text{m}$ ,  $r = 2.5 \text{ cm}$ ,  $d = 0.5 \text{ cm}$ ). The surface area of this material exceeded considerably that of the previously used chips. The test setup is represented schematically in Fig. 1b. The individual disks were separated by PTFE spacers of 2 mm thickness. Absorption took place at a temperature of 80 °C. The plastic disks of the cartridge were analyzed separately in order to obtain the absorption profile.

## 3. Results

### a) Test series 1

In Fig. 2 the curves for the separation efficiencies of the individual plastics are represented as a function of temperature. It is clearly visible that PP and PE have the best separation efficien-

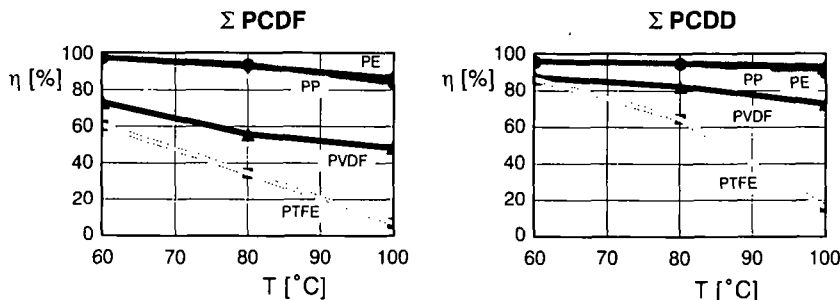


Fig. 2: PCDD/F separation efficiencies of various plastics

cies over the entire temperature range. PVDF exhibits a far smaller absorption level. Absorption by PTFE which is significant at 60 °C hardly exists at 100 °C. Decreasing separation efficiency with increasing temperature can easily be explained by studying the separation curves as a function of the degree of chlorination of ten PCDD/F homologues.

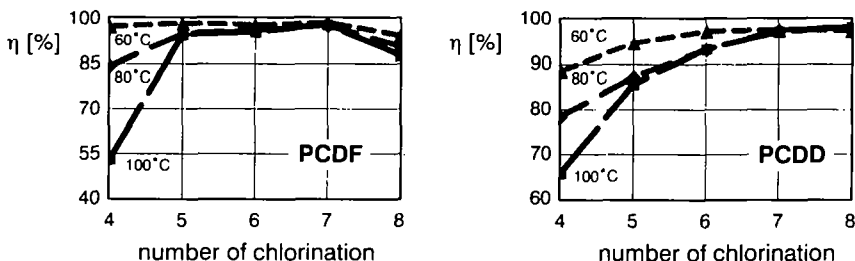


Fig. 3: PCDD/F separation efficiencies of PE

In Fig. 3 these separation curves are shown for PE. Analogous results are obtained for the other materials. It is obvious that the absorption of tetrachlorinated PCDD/F is lower at higher

temperatures, while higher-chlorinated PCDD/F remain practically unaffected. This may be attributed to the dependence of absorption on the vapor pressure of the compounds.

*b) Test series 2*

The absorption of PCDD/F in the PE disks became nearly quantitative after 2 disks (1cm) already. Small amounts (<5%) of TCDF only could be detected in the third disk. In contrast to this, only small amounts of chlorobenzenes and chlorophenols (<5%) were absorbed. As far as these compounds were concerned, separation efficiency also was strongly dependent on the degree of chlorination. The results obtained for the absorption of PCDD/F, chlorobenzenes and chlorophenols on PP were identical to those of PE within the limits of error.

#### 4. Conclusions

PE and PP are perfectly suited for PCDD/F separation in the temperature range of up to 80°C. Small amounts of chlorobenzenes and chlorophenols only are separated.

Due to these results and the possibility of PCDD/F desorption at a higher temperature, the two concepts<sup>3)</sup> represented in Fig.4 may be applied:

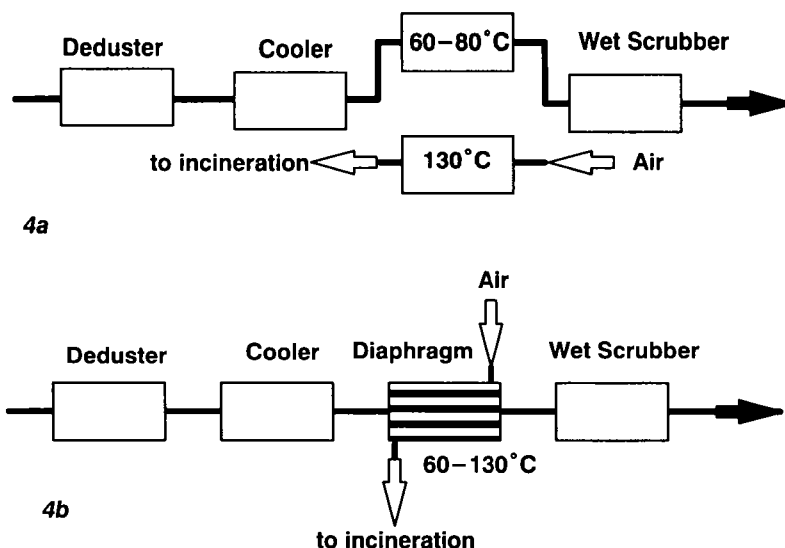


Fig.4: Concepts for PCDD/F reduction in the exhaust gas

- Two parallel fixed-bed filters (4a) are installed in the exhaust gas flow downstream of the deduster and upstream of the scrubber. Both filters are operated alternately. One filter is operated in the temperature range of 60–80°C. The other fixed bed is regenerated by air at a temperature of about 130°C. The air loaded with the desorbed polyhalogenated compounds is supplied to the incineration furnace with the compounds being thermally destroyed.

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- Downstream of the deduster the flue gas flows through a cooler and subsequently enters a diffusion system (4b) at a temperature of 80–130°C. This system mainly consists of a thin PP diaphragm with a large surface area. In contact with the diaphragm, PCDD/F is absorbed and diffused through the material. The air that is preheated in the cooler and directed in a counterflow absorbs the PCDD/F and is subsequently fed into the incineration furnace.

## 5. References

- 1) Vogg, H., Kreisz, S., Hunsinger, H.: Wet scrubbers – a potential PCDD/F source? *Organohalogen Compounds* Vol. 20 (1994), 305–307
- 2) Kreisz, S. Hunsinger, H. Vogg, H.: A simple procedure for the determination of PCDD/F, chlorophenols and chlorobenzenes in the stack gas of municipal waste incinerators, *Organohalogen Compounds* Vol. 19 (1994), 231–234
- 3) Patent pending