CARBON DOPED POLYPROPYLENE AS PCDD/F ADSORBER

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Introduction

Within the framework of the experiments using a regenerable PCDD/F separator [1] it became obvious that at a temperature of 80°C, tetrachlorinated PCDD/Fs break through a 45 cm thick Polypropylene (PP) fixed bed within a period of about 4 weeks. The reasons are reversible absorption and diffusion of PCDD/Fs in PP [2]. The same process, in principle, takes place in wet scrubbing systems which are build from PP. This results in undesired high PCDD/F emissions. Starting from these findings, the conception of suppressing PCDD/F desorption by introducing a strongly adsorbing filler material into PP has been developed [3]. This material combines the advantages of PP (selective PCDD/F separation, no wear) with those of a filler material (strong, irreversible PCDD/F adsorption). Such a material was considered to be suited both for a fixed-bed filter in an exhaust gas system as well as for structural components of the wet scrubbing system.

Preliminary considerations:

- The filler material must exhibit an irreversible adsorption of PCDD/F.
- The filler material has to be distributed homogeneously in the PP
- The amount of filler material on the PP surface must be minimized in order to avoid wear and adsorption of other flue gas compounds.
- Mechanical and chemical properties of the PP must not be changed significantly.

Taking these boundary conditions into account, it was decided to introduce fine dispersed particles of carbon in different forms into the PP. In this paper the results of the experiments are described, which are performed with finely milled (<100 µm) carbonized lignite-doped PP.

Methods and Materials

The non-doped PP was a technical product (NOVOLEN N1100) produced by BASF AG, Ludwigshafen. It is always referred to as PP in the present paper.

For the production of C-doped PP, carbonized lignite and PP were mixed and granulated in a two-component extruder. The experiments were performed using PP containing 10 wt.% carbonized lignite. This material shall hereinafter be referred to as C-PP.

The experiments were conceived as comparative measurements. This means that an experiment was performed using PP and C-PP with the experimental conditions being almost identical. Two different experiments were performed.

Exèriment 1

In this experiment the time dependence of the PCDD/F separation efficiency of PP and C-PP from the gas phase was studied.

The experimental setup is represented schematically in Fig.1. PCDD/F-loaded PP components from a technical facility were put into a heating cabinet and passed by ambient air at about 120 °C for

PCDD/F release. It had been known from former experiments that a relatively constant PCDD/F concentration of about 500 ng PCDD/F/Nm^3 can be generated by this setup over a period of several weeks. This PCDD/F-loaded air was passed through a fixed bed of PP or C-PP in a glass column (diameter: 4.5 cm) at 78-80 °C. The fixed bed was build up of several individual beds. PCDD/F concentrations were sampled continuously at the inlet and outlet of the PP bed. All system components in contact with PCDD/F consisted of silanized glass. The adsorber cartridges of the sampling systems were exchanged simultaneously at intervals of several days and analyzed for PCDD/F.

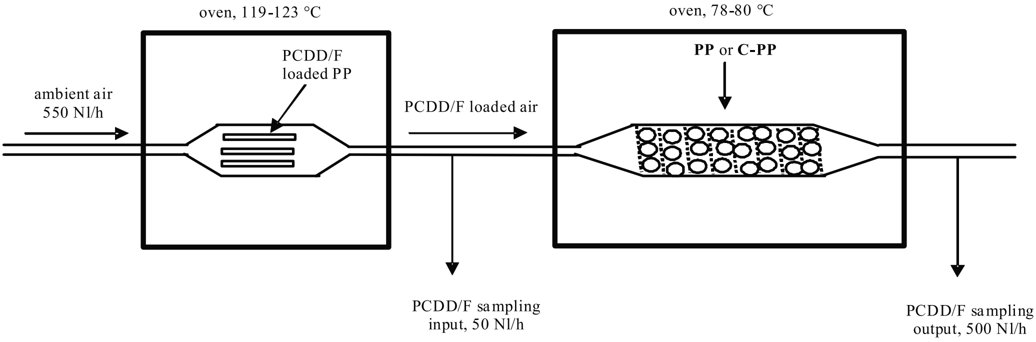


Figure 1. Scheme of the experimental setup of experiment 1.

Experiment 2

This experiment served to investigate the desorption behavior by passing hot ambient air over PCDD/F-loaded material. In a heating cabinet, PCDD/F-loaded PP and PCDD/F-loaded C-PP were passed by heated ambient air (flow rate: 100 Nl/h, temperature: 120 °C) in a silanized glass tube. The emitted PCDD/Fs were sampled directly afterwards on carbonized lignite. The desorption time was 24 h. Upon the completion of the experiment, PCDD/F loading of the carbonized lignite was analyzed.

Results

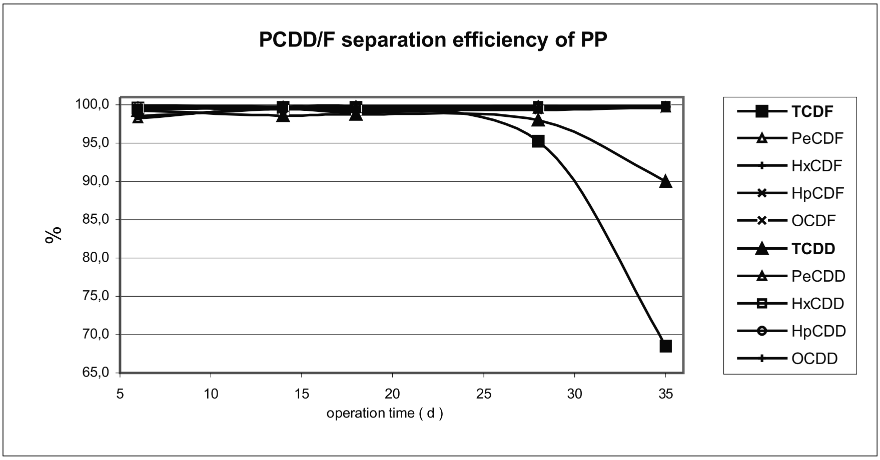
Experiment 1

The separation efficiency of experiment 1 is plotted in Fig.2. It is obvious that in the case of PP the separation efficiency of highly chlorinated PCDD/Fs remains practically constant over the entire experiment duration, while the separation efficiencies of tetrachlorinated PCDD/Fs drop rapidly after about 30 days.

The results of the experiment with C-PP shows clearly that the separation efficiencies for all degrees of PCDD/F chlorination remain practically constant over the entire experiment duration.

Experiment 2

It is evident from the measured values that the amount of PCDD/F that may be desorbed thermally from C-PP is at least by a factor of 50 lower than the desorption from PP (Fig. 3). This result shows that the predominant PCDD/F fraction is adsorbed on the carbon particles in C-PP and can no longer be desorbed thermally. The negligible amounts of PCDD/F emitted into the gas phase from C-PP had not yet been adsorbed on C, but only absorbed in the PP matrix



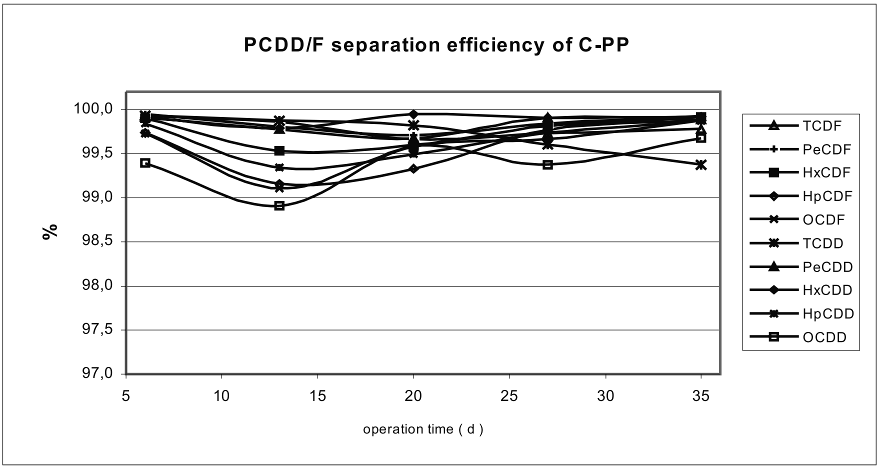


Figure 2. Separation efficiencies of PCDD/Fs in experiment 1

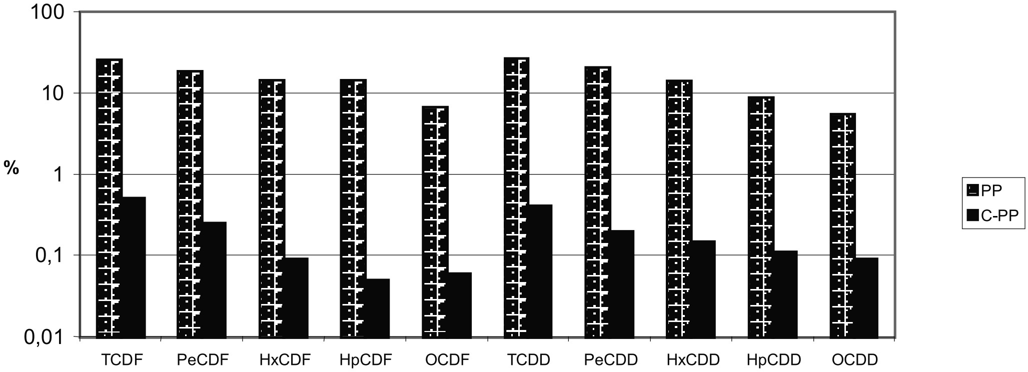


Figure 3. Desorbed amount of PCDD/F (% of total PCDD/F-loading.)

Conclusions

Comparison of the results obtained with C-doped and pure PP shows that the C-doped material exhibits the expected properties:

- The PCDD/F separated from the gas phase in the C-PP granules are not emitted again. This means that the filler material prevents PCDD/F-desorption from the material even at a temperature of 120 °C.
- Service life of a fixed-bed filter with a C-PP adsorber is much longer than that of a PP adsorber.
- The use of C-PP instead of PP as construction material in wet scrubbing systems seems to be a very simple and economical way to prevent the known memory effects of PCDD/F.

References

1. S. Kreisz, H. Hunsinger, H. Seifert, Chemosphere 40, 1029-1031 (2000).
2. S. Kreisz, H. Hunsinger, H. Seifert, Organohalogen Compounds 45, 435-437 (2000).
3. Patent pending.