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THE EFFECT OF INDOOR PARTICLES ON CELLULOSE DEGRADATION

Ludmila MAŠKOVÁ[1], Benjamin BARTL[2], Jiří Smolík[1], Petr VODIČKA[1]

[1]Institute of Chemical Process Fundamentals, CAS, Prague, Czech Republic,
maskova@icpf.cas.cz
[2]National archives, Prague, Czech Republic

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INTRODUCTION

Indoor air pollution in libraries and archives can be harmful to paper-based materials stored there. Adverse effects caused by gaseous pollutants are well described, but less is known about airborne particles. The discussion regarding this issue mostly concerned the soiling of the paper, the possibility of surface abrasion or microbiological infestation (Hatchfield, 2002), but studies about the effect of particulate matter (PM) composition are scarce. This work was focused on the changes in the properties of cellulose-based paper caused by different size-resolved chemical components of PM.

EXPERIMENTAL SETUP

The sampling was carried out in the winter, spring, summer and autumn of 2012. A 24-h samples were collected using six Leckel LVS-3 instruments (Sven Leckel Ingenieurbüro, Germany). The fractions PM1 and PM10 from the indoor air of depositories of the State Regional Archives in Třeboň and the Research Library of South Bohemia at Zlatá Koruna were collected on cellulose filters (Whatman 41), which were selected as a representative of cellulose-based paper. In parallel the same size fractions were collected on Teflon (Pall, pore size 2 μm) and quartz filters (Pall, Tissuequarz). These samples were analysed gravimetrically (Sartorius M5P, Data Weighing Systems, USA), by Ion Chromatography (Dionex ICS-5000, Thermo Scientific, USA), PIXE (3MV Tandetron accelerator, High Voltage Engineering Europa, Netherlands) and thermal-optical method (EC/OC analyser Model 4, Sunset Laboratory, USA), giving mass, ionic, elemental and organic (OC) and elemental carbon (EC) concentrations.

The cellulose samples were aged at 80 °C and a relative humidity of 65 % for 28 days in the environmental test chamber (Espec PR-2KP, Japan), according to the standard ISO 5630-3:1996. The extent of degradation was expressed as a decrease in the viscosity-average degree of polymerisation (DP_v) of cellulose measured by a semi-automatic viscometer (TV2000AKV, Tamson Instruments, Netherlands).

RESULTS AND CONCLUSIONS

The submicrometre fraction dominated in all samples, constituting more than 80 % of PM. Organic matter was the dominant component of both fine and coarse fractions. In the fine fraction, the next most abundant components were EC and sulphate, and in the

coarse fraction the next most abundant were crustal matter and sulphate (Mašková et al., 2015).

The results showed that the cellulose-based paper can undergo substantial changes when contaminated by PM and artificially aged. The decrease of the DP_v of cellulose showed a negative correlation with the deposited mass of sulfate in the particles. Considering the particle size fraction, the results suggest the decisive importance of the fine PM (Figure 1) (Bartl et al., 2015).

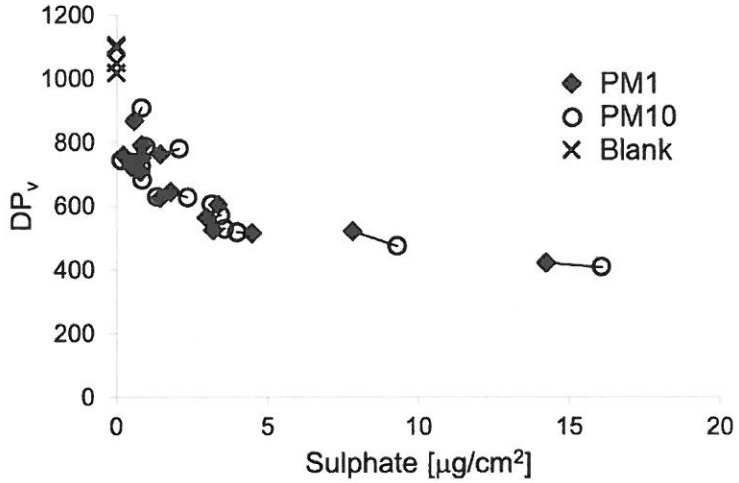

Fig. 1: DP_v of cellulose in relation to the deposited sulfate mass. The parallel PM1 and PM10 samples are connected by a line. Blank = unexposed aged filters.

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