Diffusive sampling as a tool for monitoring nitric acid in a museum

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Atmospheric emissions of nitrogen are predominantly in the form of nitrogen oxide. In the atmosphere this species is converted by oxidation first to nitrogen dioxide and then to nitric acid. The exposure to nitric acid may damage objects kept indoors, most especially textiles and dyes. Currently, there is substantial evidence that a large number of pigments are sensitive to nitric acid. Deposition of this species onto the surface of an object may cause chemical damage and molecular changes have been identified mainly by mass spectrometry studies. The principal aim of this study is to assess the threat that the oxidative chemistry of nitrogen and in particular of nitric acid poses in the museum environment in Europe. A specially designed diffusive sampler that selectively collects this pollutant was developed. Diffusive samplers are an ideal tool for determining the pollutant distribution in more than one room simultaneously in comparison to outdoor concentration. They are useful to assess integrated concentration levels over long period of time. The main advantage of these sampling devices compared with the pump-dependent active sampling procedure (i.e. diffusion denuders), is cost effectiveness and simplicity. Indoor and outdoor nitric acid together with NOx, NO2, HONO and O3 was determined as part of a comprehensive air quality characterisation study in the framework of an EU – founded Project (MIMIC). Thirteen sites belonging to seven museums in four different Countries that include Northern (U.K. and Denmark) and Southern Europe (Spain and Italy) locations were sampled on a monthly basis. Sampling was continuously conducted since March 2001 up to date at the Segovia El Alcazar, from 2001 to 2003 at the Uffizi in Florence and at the National Museum of Denmark and for shorter period in the other locations. Average indoor nitric acid concentrations of up to 1.3 ?g m^{-3} were measured at locations that lacked any pollutant removal capability. Nitric acid concentrations typically between 0.1 and 0.3 ?g m^{-3} were measured in locations fitted with air conditioning systems. Indoor/outdoor (I/O) ratios were used to provide estimates of the effective penetration efficiency. It was found that the indoor environment can act as a sink for nitric acid and that the levels of nitric acid indoors basically depend on ventilation rate. The results obtained also indicate that indoor ozone and nitrogen dioxide can lead to the formation of nitric acid.