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H_2O_2 + mineral oxide (dust) surfaces

Experimental data

Parameter	Temp./K	Reference	Technique/Comments
Experimental uptake coefficients: γ			
1.5×10^{-3} (TiO$_2$, 15% RH)	298	Pradhan et al., 2010a	AFT-CIMS (a)
5.0×10^{-4} (TiO$_2$, 70% RH)			
$(3.33 \pm 0.26) \times 10^{-4}$ (Gobi sand, 15% RH)		Pradhan et al., 2010b	AFT-CIMS (b)
$(6.03 \pm 0.42) \times 10^{-4}$ (Gobi sand, 70% RH)			
$(6.20 \pm 0.22) \times 10^{-4}$ (Saharan dust, 15% RH)			
$(9.42 \pm 0.41) \times 10^{-4}$ (Saharan dust, 70% RH)			

Comments

(a) H_2O_2 (initial concentration $\approx 4.1 \times 10^{12}$ molecule cm^{-3}) was detected by CIMS using CF_3O^- (m/z = 85) as a reagent ion. A sub-micron aerosol was generated by nebulising an aqueous dispersion of TiO$_2$ particles followed by diffusion drying. Particle number and size distribution was analysed using a DMA, giving typically surface area of $S_a = 6 \times 10^{-3}$ cm^2 cm^{-3} and D_{max} of 0.45 μm at 40% RH. The uptake coefficient was calculated using the time- and aerosol area dependent loss rate of H_2O_2, which was first order in all cases. Uptake coefficients (γ) were measured at relative humidities of 15, 35 and 70 %.

(b) Experimental method as in comment (a). For Gobi sand the available surface area was mainly from particles of diameter ~0.4 μm, for Saharan dust ~0.2 μm. The relative humidity was varied between 15 and 70 % (not all uptake coefficients obtained are listed in the table above).

Preferred Values

Parameter	Value	T/K
γ (15-70 % RH)	$6.24 \times 10^{-4} - 1.87 \times 10^{-6}$ RH $+ 9.37 \times 10^{-8}$ (RH)^2	298

Reliability

Δ log (γ)	0.5

Comments on Preferred Values

The uptake kinetics of H_2O_2 on mineral dust material has been reported in two publications from the same group (Pradhan et al, (2010a, 2010b)). Pradhan et al., found irreversible uptake of

H2O2 to sub micron Saharan dust, Gobi sand and TiO_2 aerosol substrates, but no gas phase products were detected. For TiO2, an increase of γ was observed as RH decreased below ~ 40%, but γ remained approximately constant above 50% RH. This was attributed to competition between water molecules and H_2O_2 for surface sites. In contrast, the uptake of H_2O_2 to both Gobi sand and Saharan dust became more efficient with increasing RH. No dependence of γ on [H_2O_2] was observed. In this case, the authors argue that the increasing uptake with RH is due to dissolution of H_2O_2 in surface adsorbed water.

Our preferred values are based on the data for Saharan dust, which is most likely to best represent atmospheric mineral aerosol. The parameters were derived by fitting a polynomial to data read from a graph and should not be extrapolated beyond the range given. The error limits are expanded to reflect this and the fact that (to date) the data are only reported in a discussion paper.

References

Pradhan, M., Kalberer, M., Griffiths, P. T., Braban, C. F., Pope, F. D., Cox, R. A. and Lambert, R. M., Environ. Sci. Technol., 44, 1360-1365, 2010a.

Pradhan, M., Kyriakou, G., Archibald, T., Papageorgiou, A. C., Kalberer, M., and Lambert, R. M.: Atmos. Chem. Phys. Disc. 10, 11081-11107, 2010b.

H$_2$O$_2$ + Saharan dust (Pradhan et al, 2010b)