**INTRODUCTION**

Sulfurous acid (H<sub>2</sub>SO<sub>3</sub>) has never been characterised or isolated on Earth. This is caused by the unfavourable conditions within the atmosphere. Such conditions (high temperature, water content and oxidation), however, can be found on the Jupiter moons Io and Europa. Aqueous dispersions of sulfur dioxide (SO<sub>2</sub>) exist in the Earth’s atmosphere.

Soluble trace gases such as Ammonia, NH₃, are produced from agricultural sources and represent a significant atmospheric pollutant in Ireland.

Aerosols are tiny particles suspended in the air. Those larger than about 1μm in size are mainly produced by windblown dust and sea-spray. Aerosols smaller than 1μm are mostly formed by condensation processes e.g. conversion of SO₃ gas released from volcanic eruptions to sulfate-type particles.

The main purpose of the research is to elucidate the various mechanisms by which sulfate ions can be formed from SO₂ in aqueous aerosols relevant to the polluted atmosphere. Hence the interaction between SO₂·H₂O aerosols with ammonia over a range of concentrations and humidities was studied. Oxalic acid was then introduced to this system at different concentrations.

**AIM OF THIS WORK**

The primary aim of this work was to investigate the reaction between ammonia and sulfuric acid aerosols, in order to understand the formation of sulfate ions under atmospheric conditions. The study was conducted using various methodologies such as mass spectrometry and gas chromatography-mass spectrometry (GC-MS).

**RESULTS: ‘H₂SO₃’**

- **1% wt SO₂·H₂O 20% RH**
  - The concentration of SO₂·H₂O aerosols was monitored at different humidities from 0% to 100% RH.
  - The maximum concentration was observed at 10% RH.

- **1% wt SO₂·H₂O + 300ccm NH₃ 60% RH**
  - The addition of ammonia to SO₂·H₂O aerosols was found to increase the concentration of sulfate ions.
  - The maximum concentration was observed at 60% RH.

**RESULTS: ‘H₂SO₃/C₂H₂O₄’**

- **0.05% wt oxalic acid 20% RH**
  - The concentration of oxalic acid aerosols was monitored at different humidities from 0% to 100% RH.
  - The maximum concentration was observed at 50% RH.

- **0.05% wt oxalic acid and ‘sulfurous’ acid 20% RH**
  - The concentration of oxalic acid and sulfurous acid aerosols was monitored at different humidities from 0% to 100% RH.
  - The maximum concentration was observed at 70% RH.

**INSTRUMENTATION**

- **AEROSOL GENERATION**
  - SO₂·H₂O aerosol generated by passing a flow (200-500 cm³) of air over a heated solution or via a Nebuliser.

- **RELATIVE HUMIDITY (RH) measured between 1% and 70%**

- **PARTICLE SIZER (SMPS)**
  - Monitors aerosol fraction, particle size, mass, surface area, volume.

- **CHEMILUMINESCENCE**
  - NOx Monitor. Catalytic oxidation of NH₃/NH₄⁺ to NO

- **FTIR**
  - SO₂ is produced from “sulfurous acid”, in three different forms, aqueous, liquid and gas (1347, 1356, 1373 cm⁻¹)

- **AMMONIA**
  - 0.05% wt NH₃ and 0.25% wt’sulfurous’

- **DISCUSSION**

  - ‘Sulfurous acid’ aerosol exists as SO₃ in three forms. With NH₃, bisulfite isomers and SO₂⁻ were observed only at <60% RH: indicating the importance of H₂O in the mechanism.

  - Oxalic and ‘sulfurous’ acids together gave rise to a variety of aerosols. Deprotonation of oxalic acid resulted in more uptake of ammonia as opposed to the sulfurous counterpart.

  - Oxalic acid is mainly produced from biomass burning, vehicle exhaust emissions and biogenic activity. The aerosols formed from condensation and nucleation play an important role in cloud and fog formation and their radiative properties.

  - Health implications when inhaled;
  - Reduce and distort visibility;
  - Climate change;
  - Provide surfaces for ‘new’ catalytic chemical reactions.

**CONCLUSION**

The formation of sulfate ions is influenced by the concentration of sulfuric acid aerosols and ammonia. The study shows that the addition of ammonia to sulfuric acid aerosols increases the concentration of sulfate ions.

**FUTURE OUTLOOK**

Vary the interaction times of ammonia with the aerosols to probe mechanistic and kinetic details. Investigate the interactions between NH₃, H₂SO₃, ‘H₂SO₄’ and other organics such as malonic and succinic acid.

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