Environmental Science

Q3 What are the various mechanisms involved in atmospheric SO_2 removal? (2019)

Introduction:

Sulphur dioxide (SO_2) is a colorless, non-flammable gas. The most significant anthropogenic emission sources of SO_2 are from combustion of sulphur-containing fossil fuels, smelting sulphide ores, and Petroleum refining. Other less significant sources include chemical and allied products manufacturing, metal processing, other industrial processes, and vehicle emissions.

The presence of sulphur dioxide in the earth's atmosphere is a critical environment concern due to its detrimental effects on air quality, human health and the eco system.

Sulphur Dioxide Removal Mechanisms:

Once SO_2 is released ~~from~~ into the atmosphere, it may be converted to other compounds or removed from the atmosphere by various mechanisms

These mechanisms are essential in mitigating the negative impacts of SO_2 emission on air quality and the environment.

ⓐ Dry Deposition:

Dry Deposition occurs when SO_2 gas comes into direct contact with surfaces such as solid particles, vegetation, or buildings. The SO_2 molecules are physically ~~adsor~~ adsorbed onto the surfaces, effectively removing them from the air. This process is more effective in areas with high concentrations of airborne particles, as these particles provide more surface area for SO_2 to adhere to. Additionally, dry deposition can be more efficient in regions with acidic surfaces, as SO_2 can react with the acidity and form ~~Sulfwater~~ Sulfates, which are then removed through dry deposition.

ⓑ Wet Deposition:

Wet deposition involves the dissolutions of SO_2 gas in

atmospheric water vapor to form sulfuric acid. This reaction occurs in the presence of moisture in the air. The formed sulfuric acid combines with water droplets in the atmosphere and falls to the ground as acid rain during precipitation events. The acid rain can have a significant impact on the environment, including soil and water quality, as well as damaging vegetation and affecting aquatic ecosystems.

③ **Heterogeneous Reactions:**

Heterogeneous reactions involve the interaction of SO_2 gas with atmospheric particles, such as aerosols, dust, or other particulate matter. The SO_2 molecules can adsorb onto the surfaces of these particles and undergo chemical reactions, leading to the formation of sulfate particles. These sulfate particles can then be removed from the atmosphere through dry deposition or wet deposition.

ⓓ Photolysis:

Photolysis is a process that occurs in the presence of sunlight. When SO_2 is exposed to sunlight, it absorbs energy and breaks down into sulfur oxide radicals and atomic oxygen. These radicals can participate in various atmospheric reactions. For instance, the sulfur oxide radicals can react with water vapor and other atmospheric components to form sulfuric acid. The resulting sulfuric acid can then be removed from the atmosphere through wet deposition or dry deposition.

ⓔ Chemical Transformation:

SO_2 can undergo chemical reactions with hydroxyl radicals and other atmospheric oxidants. These reactions lead to the conversion of SO_2 into sulfuric acid and other sulfate compounds. This process plays a crucial role in removing SO_2 from the atmosphere

especially in regions with high levels of oxidants. The formed sulfuric acid can be subsequently undrgo wet deposition or dry deposition.

⑦ Cloud processes:

SO_2 can be scavenged from the atmosphere by cloud droplets during cloud formation. when SO_2 is absorbed by cloud droplets, it undergoes reactions with water and other components, leading to the formation of sulfuric acid. The sulfuric acid then becomes a part of the cloud. and when the cloud precipitates, it releases acid rains or deposits sulfuric acid. containing droplets onto the earth's surface.

⑧ Reaction with Ozone:

SO_2 can react with ozone in the atmosphere, resulting in the formation of sulfure trioxide and other intermediates. These reactions are essential for understanding

the atmospheric chemistry of SO_2. Although the reaction with ozone does not directly remove SO_2 from the atmosphere, the produced sulfur trioxide can further participate in other reactions, eventually leading to the formation of sulfuric acid and contributing to the removal of SO_2 through wet or dry deposition.

According to **Katz**, the residence time of SO_2 in the atmosphere ranges from about 2 to 8 days. As per **Hidy** residence times of SO_2 in the lower atmosphere of 1 to 3 days.