

# Unraveling the Role of Sulfur Compounds and Nitrogen Compounds in Acid Rain Formation

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**Abstract** – Huge amounts, on the request for megatons, of contaminations are produced month to month to the environment both by common and anthropogenic sources. The assessment of water piece has incredible significance in understanding the environmental substance structure, as water drops rummage particles and solvent air poisons. Most understudies know that SO<sub>2</sub> is one of the poisons identified with the fermentation of the climate inferable from its oxidation in the gas or fluid stage that produces sulfate and H<sup>+</sup>, yet the circumstance is more perplexing within the sight of other basic contaminations, for example, smelling salts or formaldehyde. To give knowledge into the science happening in the gas and fluid stages, a showing is portrayed where the pH of a "raindrop" is checked during retention of SO<sub>2</sub> followed by openness to H<sub>2</sub>O<sub>2</sub>, with or without past contact with vaporous CH<sub>2</sub>O. The impact of the presence of alkalinizing substances, for example, NH<sub>3</sub> in the climate is assessed too. The raindrop is reenacted by the wet bulb of a blend glass terminal presented to the gas stage. Estimations can be made with any pH meter, in spite of the fact that information securing with a PC is beneficial to delineate the energy of the cycles, as appeared in the article.

**Keywords** – Acid Rain, Emissions Precipitation Chemistry, Trends, Sulphur Dioxide, Nitrogen Oxides, Hydrogen Ion etc.

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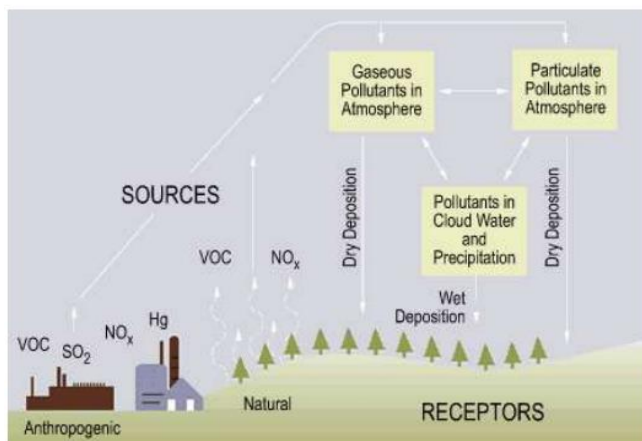
## INTRODUCTION

Oxidized sulfur (SO<sub>2</sub>) and nitrogen (NO<sub>x</sub>) mixes radiated from anthropogenic and normal sources are dependent upon various change measures inside the environment that bring about the creation of acidic substances (for example sulfuric corrosive and nitrous corrosive). Wet testimony of these acidic mixes by wash-and rainout measures is alluded to as 'corrosive downpour', and effect sly affects the vegetation of earthbound environments. The term corrosive downpour has been utilized since the nineteenth century when high centralizations of acidic substances could be found in the precipitation in close region to the producers of SO<sub>2</sub> and NO<sub>x</sub> in mechanical zones. In the 20th century, wet testimony of acidic substances has additionally been seen in far off regions of the northern side of the equator as these mixes are exposed to significant distance transport inside the climate. This article centers around the arrangement of corrosive downpour and on its effect on the vegetation of earthbound environments.

has two sections: wet and dry. Wet testimony alludes to acidic downpour, haze, and day off. As this acidic water streams over and through the ground, it influences an assortment of plants and creatures. The strength of the impacts rely upon numerous variables, including how acidic the water is, the science and buffering limit of the dirt in question, and the sorts of fish, trees, and other living things that depend on the water. Dry affidavit alludes to acidic gases and particles. About portion of the causticity in the air falls back to earth through dry testimony. The breeze blows these acidic particles and gases onto structures, vehicles, homes, and trees. Dry stored gases and particles can likewise be washed from trees and different surfaces by rainstorms. At the point when that occurs, the spillover water adds those acids to the corrosive downpour, making the blend more acidic than the falling precipitation alone. Winning breezes blow the mixes that cause both wet and dry corrosive affidavit across state and public boundaries, and once in a while more than many miles.

## What is Acid Rain and What Causes It?

"Corrosive downpour" is an expansive term used to depict a few different ways that acids drop out of the air. A more exact term is corrosive testimony, which



Researchers found, and have affirmed, that sulfur dioxide (SO<sub>2</sub>) and nitrogen oxides (NO<sub>x</sub>) are the essential drivers of corrosive downpour. In the US, About 2/3 of all SO<sub>2</sub> and 1/4 of all NO<sub>x</sub> comes from electric force age that depends on consuming petroleum products like coal. Corrosive downpour happens when these gases respond in the environment with water, oxygen, and different synthetic substances to frame different acidic mixes. Daylight expands the pace of a large portion of these responses. The outcome is a mellow arrangement of sulfuric corrosive and nitric corrosive.

### The Formation of Acid Rain

The regular wellsprings of oxidized sulfur adding to acidic precipitation incorporate microbial exercises (sulfur oxidation), gas removal from volcanoes, spray and disintegration measures. Also, the outflow of sulfur dioxide (SO<sub>2</sub>) from burning of petroleum derivative, especially of coal, contributes fundamentally to the heap of oxidized sulfur, especially in the northern half of the globe. The fundamental wellsprings of oxidized barometrical nitrogen are vehicle traffic, power plants, modern cycles and air traffic. NO<sub>x</sub> and SO<sub>2</sub> outflow from anthropogenic sources has been diminished fundamentally in the industrialized nations because of enactment, however an expansion of 30% (Wellburn, 1988) has been forecasted for the twenty-first century attributable to the expanding energy interest of the expanding total populace. Once discharged into the air, vaporous SO<sub>2</sub> is exposed to various responses, delivering SO<sub>3</sub> which breaks up in water to create sulfuric corrosive. Furthermore, SO<sub>2</sub> can respond straightforwardly with water to create sulfurous corrosive and hydrogen sulfite in addition to protons. Oxidation yields sulfuric corrosive and hydrogen sulfate, and upgrades the solvency of SO<sub>2</sub>. The oxidized N compound specially discharged from petroleum derivative ignition is nitrogen oxide (NO), which promptly responds with ozone or intermediary extremists to frame nitrogen dioxide (NO<sub>2</sub>). NO<sub>2</sub> is dependent upon various responses in the climate that produce nitric and nitrous corrosive. The vaporous sulfur and nitrogen mixes can: (1) break down in cloud beads and, in this way, are eliminated from the environment by a measure known as downpour out or (2) are assimilated by falling raindrops (wash-out). As of

late, natural acids (for example formic and acidic corrosive) produced from regular sources have been proposed additionally to be liable for acidic precipitation in far off territories.

### Consequences of Acid Precipitation for Vegetation

The openness of earthbound environments to corrosive downpour influences the vegetation in an unexpected way. Soil fermentation causes draining of K<sup>+</sup>, Ca<sup>2+</sup> and Mg<sup>2+</sup> (Van Dijk et al., 1989) and easing back down of phosphorous cycling (Carreira et al., 1997), subsequently diminishing the accessibility of these supplements for vegetation. At the point when soil fermentation is brought about by nitrate input, the concurrent expansion in nitrogen accessibility may upset the supplement equilibrium of plants since nitrogen should be the development restricting element in numerous earthly biological systems. Contingent upon the cradle limit of the dirt, broad corrosive affidavit expands the delivery and activation of aluminum from soil colloids. Along with high proton focuses, broke up aluminum represses the take-up of inscriptions by plant roots.

High proton fixations in the dirt weaken proton expulsion by the plasma film bound adenosine triphosphatases, an essential for cation take-up into the symplasm. Aluminum should obstruct cation channels (Ca<sup>2+</sup>) and transport proteins (Mg<sup>2+</sup>). Furthermore, aluminum restrains root stretching, presumably because of changes in layer properties (Marschner, 1995). Not only acid precipitation yet in addition climatic contribution of ammonium (an essential subtitle) may build soil fermentation, as ammonium take-up by plant roots is combined with proton discharge. Corrosive downpour doesn't just motivation activity draining from the dirt yet additionally from plant leaves. K<sup>+</sup>, Mg<sup>2+</sup> and Ca<sup>2+</sup>, specifically, perhaps eliminated from the covering of woods. In blend with diminished accessibility of subtitles in the dirt, this impact may upgrade supplement awkward nature. Like vaporous SO<sub>2</sub> and NO<sub>x</sub>, broken up sulfur and nitrogen mixes perhaps taken up by the over the ground portions of the plants, associating with the sulfur and nitrogen digestion of the plant and impacting pH homeostasis, especially in the leaves. The take-up of sulfate and hydrogen sulfate, just as nitrate and nitrite, should happen through dissemination inside slender water films that interface the leaf surface with the watery period of the apoplast, and may also cause protons to be brought into the apoplast. Since the take-up of the anions works either as proton symport or as OH<sup>-</sup> or HCO<sub>3</sub><sup>-</sup> antiport, the pH of the symplasm increments if inordinate anion take-up happens. To accomplish steady pH levels (pH detail) and to keep up the cation : anion proportion, natural acids, for example, malate are decarboxylated (Marschner, 1995). Fermentation may furthermore be neutralized by reduction of sulfate and nitrate and by proton-sulfate co-transport into the vacuole (Rennenberg and Polle, 1994). Support of pH detail includes costs regarding water and photosynthetic, and may accordingly clarify the

diminished phloem stacking of photosynthetic from leaves presented to climatic SO<sub>2</sub>.

Whenever raised proton fixations increment the cushion limit of the cell, unsettling influences of catalyst exercises and film bound cycles are normal. Vaporous SO<sub>2</sub> taken up by the leaves of plants is believed to be changed over to hydrogen sulfide and sulfide inside the chloroplasts. Furthermore, sulfite and hydrogen sulfite delivered from sulfate taken up possibly moved into the chloroplasts. Sulfite, or all the more likely hydrogen sulfite, is synthetically changed over to sulfate in a progression of responses that incorporate middle of the road development of revolutionaries. These revolutionaries should be the essential mixes interceding intense harms. The main impetus of hydrogen sulfite oxidation is the presence of superoxide created from photosynthetic electron transport (Robinson, 1988). Searching systems, for example, superoxide dismutase movement, may balance extremist development and increment the plant's resistance towards SO<sub>2</sub> and its disintegrated items.

Climatic sulfur mixes can be considered as supplements since they are consolidated into the ordinary pathway of sulfur osmosis. A quick motion of the oxidized sulfur taken up by above-ground parts into the pools of sulfur aggravates utilized for development and improvement may likewise forestall harm, at any rate in quickly developing plant species. NO<sub>2</sub> delivered from the NO<sub>3</sub> taken up into the symplasm of leaves might be associated with the creation of nitrosoderivatives and the decimation of amino acids. Furthermore, it is assumed that NO<sub>3</sub> can be changed over to NO revolutionaries that respond with proteins containing copper or iron. In the event that the take-up of oxidized nitrogen by the leaves stays low, it can (like sulfur) be viewed as an extra supplement that initiates the proteins of nitrogen digestion in the leaves and adds to the nitrogen supply of plants. Inside specific restricts, the plants may prevent nitrogen and sulfur oversaturation from air take-up by adapting exospheric nitrogen and sulfur assimilation to the entire plant's interest (Rennenberg and Polle, 1994; Muller et al., 1996). Notwithstanding physiological impacts at the species level, corrosive downpour strongly influences the vegetation of earthbound biological systems overall, for the most part because of changes in plant community composition towards corrosive safe species. For nitrogen, specifically, the eutrophication impacts have additionally to be thought of.

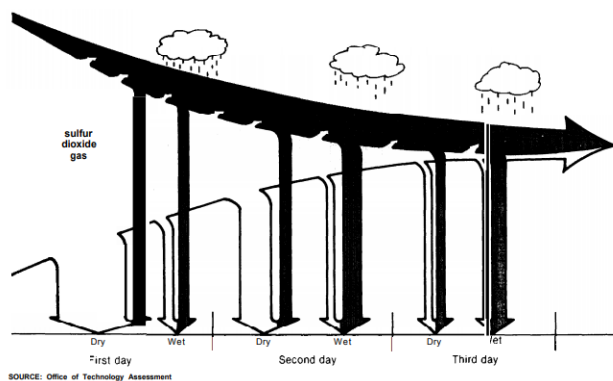
#### **Atmospheric Chemistry of the Oxides of Sulfur**

Around 26 million tons of artificial SO<sub>2</sub> are radiated in the mainland United States. Around 22 million of these tons are transmitted in the Eastern 3 I-State district. The oxidation of normal sulfur mixes could contribute essentially to air SO<sub>2</sub> fixations in locales where characteristic outflows are high (e. g., from volcanoes, or a few sorts of bogs) and artificial discharges are low. Be that as it may, on a cross country premise, under 5 to 10 percent of sulfur discharges are credited to characteristic sources. The accompanying conversation

of the different destinies of produced SO<sub>2</sub> is summed up in figure C-2. One manner by which sulfate is framed includes SO<sub>2</sub> gas cooperating with OH revolutionaries in a homogeneous gas stage response—i.e., the reactants are all in the gas stage. Since OH is exceptionally responsive with numerous barometrical parts, every OH revolutionary has a short lifetime in the climate. Daylight is vital for setting off the chain response prompting OH creation. Therefore, the best amount of SO<sub>2</sub> gas is oxidized by OH extremists during times of exceptional daylight—i.e., at early afternoon, and in the mid-year.

The most extreme rate at which this response changes SO<sub>2</sub> over to sulfate is assessed to be around 1 to 4 percent for every hour. In any case, field tests show transformation rates essentially more prominent (10 to 30 percent for every hour) than homogeneous gas-stage response rates. In this way, critical amounts of sulfate should be delivered by (fluid) stage responses or heterogeneous responses including two stages (i. e., responses of gases on either fluid beads or strong particles). In watery stage responses, SO<sub>2</sub> is broken down in water beads, where oxidants convert the SO<sub>2</sub> to sulfate. There is little arrangement with respect to which oxidizing specialist (the up-and-comers incorporate broke down oxygen, ozone, metals, hydrogen peroxide, free revolutionaries, and NO<sub>x</sub>) is generally significant under specific conditions. The pace of each oxidizing cycle may rely upon the causticity of the arrangement; the general significance of specific oxidizing specialists may, thusly, change as corrosive is shaped and the pH\* of the water bead diminishes. As sharpness expands, SO<sub>2</sub> is additionally less handily broken up, which hinders some fluid stage responses fundamentally. (For instance, the presence of nitrate mixes can expand the acidity of beads, permitting less SO<sub>2</sub> to disintegrate; the presence of alkali in the air can cradle such expansions in sharpness, permitting more SO<sub>2</sub> to break up.) Current examination recommends that the major watery stage oxidation course for SO<sub>2</sub> under average surrounding conditions is

Figure C-1.— The Effects of Time and Distance on Conversion and Deposition of Sulfur Pollution Sulfur can be kept in the two its transmitted structure, sulfur dioxide (lighter concealing), and as sulfate, in the wake of being artificially changed in the environment (more obscure concealing). The two mixes can be saved in one or the other dry or wet structure. The overall measure of sulfur kept in these structures differs with distance from emanation sources. Dry affidavit prevails in territories near emanation sources. Wet statement is liable for a bigger level of poison load in territories inaccessible from source locales.



The response with the oxidant hydrogen peroxide, since this response happens rapidly and gives off an impression of being generally autonomous of pH. An assortment of estimations show that SO<sub>2</sub> gas can be adsorbed onto particles (e. g., carbon ash in crest) and afterward oxidized to sulfate. These sorts of heterogeneous response rates might be especially critical in metropolitan crest. Gas stage, fluid stage, and heterogeneous responses may all be significant under contrasting environmental conditions, For instance, if there is no consolidated water and the centralization of particulate surfaces is low, gas stage oxidation will prevail during sunlight hours. Be that as it may, if mists or haze are available, oxidation in the watery stage can prevail.

In one or the other case, heterogeneous responses on surfaces may likewise be significant if adequate surfaces related with particulate are accessible. Such conditions are in all probability almost an emanations source—for example , in a powerplant tuft. Generally, current appraisals dependent on exact perception and model outcomes recommend that homogeneous gas stage responses represent 25 to 50 percent of sulfate framed, and watery stage responses represent the excess 50 to 75 percent on a provincial scale. SO<sub>x</sub> can be changed over to sulfate rapidly in the watery stage or in concentrated tufts (e. g., in excess of 10% every hour) or gradually (e. g., under 1 percent for each hour in the dry winter) in the gas stage. Consequently, SO<sub>x</sub> are accessible for environmental vehicle for times of 1 day to about seven days, and will travel fluctuating distances relying upon meteorology and precipitation recurrence. The structure in which it is saved relies upon the science depicted previously. Eventually, dry-stored SO<sub>2</sub> and sulfate may likewise create corrosive on the outside of the Earth following oxidation and mix with accessible water (e. g., dew). Barometrical Chemistry of Oxides of Nitrogen Manmade NO<sub>x</sub> emanations result both from nitrogen bound in energizes and from exacerbates framed from nitrogen and oxygen noticeable all around during ignition.

**REDUCING REACTIVE HYDROCARBON AND NITROGEN OXIDES EMISSIONS SIMULTANEOUSLY**

Brown haze chamber and displaying contemplates (fig. C-3) show that synchronous control of both RHC and NO<sub>x</sub>—keeping their fixation proportion consistent—

would decrease ozone focuses. As referenced above, less nitric corrosive development is additionally expected since the diminished NO<sub>x</sub> restricts how much corrosive can be framed. For this situation, the oxidation pace of SO<sub>2</sub> is additionally liable to be decreased.

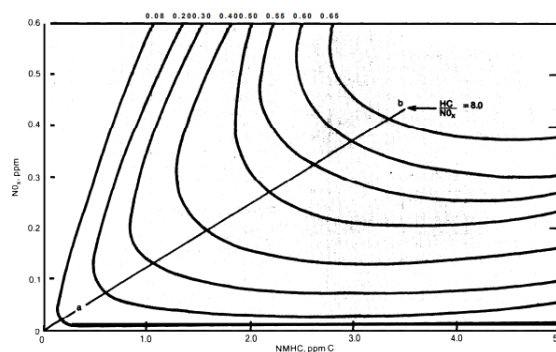
**REDUCING SULFUR DIOXIDE EMISSIONS (ALONE)**

Brown haze chamber and displaying contemplates (fig. C-3) show that synchronous control of both RHC and NO<sub>x</sub>—keeping their fixation proportion consistent—would decrease ozone focuses. As referenced above, less nitric corrosive development is additionally expected since the diminished NO<sub>x</sub> restricts how much corrosive can be framed. For this situation, the oxidation pace of SO<sub>2</sub> is additionally liable to be decreased.

**REDUCING SULFUR DIOXIDE EMISSIONS CONCURRENTLY WITH REACTIVE HYDROCARBONS AND NITROGEN OXIDES**

There are considerable vulnerabilities in even subjectively anticipating how at the same time diminishing SO<sub>2</sub> , NO<sub>x</sub> , and RHC discharges from given sources would influence corrosive testimony at a removed receptor site. Changing the groupings of RHC and NO<sub>x</sub> in a metropolitan crest that associates with SO<sub>2</sub> from a force plant tuft may well modify the measure of corrosive affidavit at a specific downwind area, yet the meteorological and substance factors included are intricate to the point that no dependable quantitative evaluations can be made right now. For instance, changing RHC and NO<sub>x</sub> outflows without changing SO<sub>2</sub> emanations could influence the testimony of sulfuric corrosive at a given area by changing the centralizations of accessible oxidants required for changing SO<sub>2</sub> over to sulfate. Further impacts could emerge if modifications in RHC and NO<sub>x</sub> focuses influenced the pH

**Figure C-3.—Typical Ozone Concentrations Formed From RHC-NO<sub>x</sub> Mixtures**



Of existing cloud beads, e.g., through the development and disintegration of nitric corrosive in the cloud. For the fluid stage oxidation of SO<sub>2</sub> , in which the significant cycles are pH-subordinate, changes in cloud corrosiveness levels could change

the pace of sulfuric corrosive arrangement. On the off chance that the net consequence of changed RHC and NOX outflows is quicker transformation of S02, sulfuric corrosive will shape and be stored nearer to sources. In the event that the convergences of RHC and NOX are modified with the end goal that less oxidizing material is at first accessible, sulfuric corrosive is stored further from emanation sources. Subsequently, modifications in the pace of oxidation could change the measure of corrosive statement to a particular area, however not the aggregate sum of sulfur saved (e. g., the amount of S02 and sulfates) over the whole downwind region. The sulfur produced will at last re-visitation of the surface sooner or later. On the off chance that NOx and RHC emanations are diminished with the end goal that their proportion stays steady while S02 discharges are diminished, all out statement of both sulfuric and nitric corrosive will diminish and add up to ozone creation will diminish.

### **INCREASE NITROGEN OXIDES, HOLDING HYDROCARBON AND SULFUR DIOXIDE EMISSIONS CONSTANT**

This situation is probably going to happen without significant changes in current air contamination control guidelines. Future expansions in NOX levels are anticipated (essentially from utilities and the mechanical area), while S02 discharges are projected to remain genuinely consistent or increment marginally throughout the following 20 years (see application. A). Chamber contemplations show that expanding NOX from exceptionally low levels, holding RHC levels steady, causes top ozone fixations to increment. As NOX levels are additionally expanded, ozone fixations arrive at a most extreme and afterward decline with additional expansions in NOx (see fig. C-3). The centralizations of other nitrogenous poisons, for example, nitrous corrosive likewise for the most part increment with expanded NOX. Expanding NOX outflows while S02 emanations are held steady will increase nearby corrosive statement because of nitric corrosive. Since transmitted NOX are oxidized more promptly than S02 in the gas stage, increasing NOX focuses may extend the topographical zone over which sulfur testimony happens. Source-Receptor Relationships. A significant objective of environmental science is to foresee for a given contamination source, the portion of poisons at a particular area downwind, and how changes in that source's emanations would change the toxin trouble at the receptor site. Source-receptor connections are dictated by the area and nature of the essential toxin emanations (e. g., S02, NOX, RHC) and by related meteorological, substance, and actual cycles that happen as the toxins make a trip from the source to the receptor. Current long-range transport models that join complex meteorology (i. e., those utilized in the Canadian-American Work Group exertion under the Memorandum of Intent) endeavor to reproduce synthetic changes of S02 to sulfate by expecting that the mind boggling set of substance cycles will adjust after some time and distance to rough a consistent normal pace of change.

This streamlining supposition makes territorial scale estimations manageable; unrefined source locales and receptor districts can be recognized for sulfur mixes. Since they are direct models, lessening outflows in source areas brings about a relative decrease of affidavit in receptor districts. These models seem to describe the current circumstance for wet testimony genuinely well. They utilize real discharges as information, and can duplicate noticed degrees of local wet sulfate stored inside a factor of 2. The primary endeavor to consolidate numerous compound responses including NOX, S02, and RHC into a longrange transport model—called the Rohde model—contains 19 synthetic conditions however essentially no meteorology. Three of the conditions concern sulfuric or nitric corrosive creation. Sixteen of the conditions portray the gas stage photochemistry related with the RHC/NOX frameworks, ozone, hydroxyl revolutionary, and hydrogen peroxide—all mixes associated with really shaping the corrosive.

The entirety of the fluid and heterogeneous stage responses are joined into one rearranged condition. This model expects that dry statement diminishes with respect to emanations. Notwithstanding, it predicts that diminishing outflows may make wet testimony decay not exactly relatively - e.g., a reaction 60% as incredible. \* Recently, a Committee of the National Academy of Sciences modified the science in the Rohde model to fuse new research facility results. It found that the new presumptions significantly diminished the nonlinearity in the relationship between surrounding S02 fixations and encompassing sulfate focuses. Utilizing at present accessible information, the NAS report infers that, "there is no proof for solid nonlinearity in the connections between long haul normal discharges and statement. Quite certain source-receptor connections can't be characterized except if the conduct of any remaining poisons is known. Given the intricacy of the environmental science alone, just as the need to create point by point outflow inventories (particularly for NOX and RHC), and natural meteorological inconstancy, it is impossible that an authoritative model coordinating S02, NO2, and RHC will be created in the following decade or two. Choices to control or not to control antecedent emanations throughout this time-frame should be made without the advantage of such exact data.

### **CONCLUSION**

As of late, earnestness of the acidic testimony issue is perceived by countless world nations. Acidic statement is the expulsion of sulfates and nitrates from the climate by both wet and dry cycles. Thusly, the general cycle is all the more appropriately named corrosive statement. Expanded precipitation corrosiveness has all the earmarks of being because of sulfuric (65%) and nitric acids (30%). The evident significant wellsprings of antecedents, sulfur dioxides (S02) and nitrogen oxide (NOx), for these solid acids incorporate fossil-fueled power plant, mechanical boilers, metal smelters and autos in particular,

corrosive affidavit can influence soundness of an individual. It can hurt us through the dirt and releases, the environment or man-made materials and structures. One of the genuine impacts of corrosive testimony on human is respiratory issues.

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