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A Review on Impact of Anthropogenic Sulphur Dioxide Pollution on Health and Environment

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Review Article

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ABSTRACT

The explosive global change in the emissions of Sulphur dioxide (SO_2) over the decades have brought about tremendous effects in the regional as well as global scale in the composition and quality of air that we breathe. The global SO_2 emission peaked in the 1970s, decreased until 2000 and has risen to peak again mainly as the result of increased globalization in developing countries. The global estimation is surprisingly low but the regional output of SO_2 is high. The main hotspots being in East Asia Countries. The Sulphur aerosols not only impacts the animals' health, but those of the ecosystems at large. SO_2 contributes to global warming, ozone depletion, acid rain, smog etc. that has brought disastrous environmental conditions. WHO recommends a maximum exposure of not more than 0.5 ppm for around 24 hours' span. SO_2 reacts with other gases to form sulphate particles, constituent of particulate matters i.e. PM 2.5 concentrations, the exposure to which causes skin, respiratory, reproductive failures and cardiovascular ailments. This study, as such, is meant to bring into light the sources of SO_2 and its harmful effects on health and environment at large. Air pollution is a major issue with adverse effects prevailing over the globe at present.

Keywords: SO_2; anthropogenic; environment; global.

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1. INTRODUCTION

What is Sulphur dioxide? Sulphur dioxide (SO_2) belongs to Sulphur oxides, a group of highly reactive gases, with a mol.wt. of about 64.07 g/mol (heavier than air), density of 2.26 g/L with respect to air, boiling point of -10 oC and freezing point of -73oC. It is a colorless pungent gas soluble in water and slightly to an extent in sulphuric acid, acetic acid and even alcohol. It is corrosive to organic materials and is toxic to inhalation. SO_2 is produced as precursor of sulphur trioxide (SO3) in industries to make sulphuric acid, sulphurous acid, sulphides etc. It is used widely as a disinfectant, bleach, refrigerant and also as preservatives in food items.

2. SULPHUR DIOXIDE SOURCES

The sources of SO_2 are numerous and grouped as natural and anthropogenic. The natural sources are volcanic eruptions, sudden outbreaks of natural wildfires and those of fitoplanktons (SO_2 emission in highest amount in oceans) while the automobiles release and fossil fuel combustions, aerosols in industries, petroleum and metal smelting, equipments, shipments in large water bodies etc., are some of the major anthropogenic sources. Sulphur aerosols and particulate matters constitute the secondary pollutants formed from SO_2.

Anthropogenic sources in industrialized regions have greatly increased in loading of SO_2 in air. The widespread fossil fuels combustion has greatly increased sulphur dioxide emissions such that the man-made sources surpasses the natural sources in the total global estimate [1]. The sulphur aerosols brought radiative forcing changes which is second to carbondioxide [2]. The emissions from fuel based activities in shipping were reduced to a great extent in the last decades [3-6]. The SO_2 emission from petroleum products. were studied by Olivier and Berdowski [7] and Olivier et al. [8]. The emissions of sulphur gases from biomass and agricultural combustions were estimated by Fernandes et al. [9]; Yevich and Logan [10]; Eggleston et al. [11]; Lamarque et al. [12].

3. HEALTH AND ENVIRONMENTAL EFFECTS OF SULPHUR DIOXIDE

Impacts of sulphur dioxide pollution ranges from minor irritations of skin to severe respiratory problems like asthma, emphysema, bronchitis, allergies and even worse, adverse cardiovascular diseases and even cancers. In plants and vegetations, it inhibits growth, flowering patterns and yields, photosynthesis, causes chlorosis, necrosis etc. It is the main component of acid rain that deteriorates monuments, buildings and further acidifies water sources, damages trees and soil and also contributes to the whole global warming index.

The health effects of sulphur oxides, its exposure and relative health consequences was studied and reviewed by David P. Rall [13]. The formation of gaseous pollutants and their harmful effects on health and environment with proper reasoning on the anthropogenic causes and its pertinent thermal pollution was studied by Yousef [14]. Carl Setterstrom analyzed on the effects of sulphur dioxide on plants and animals and also on low concentration effects of it. He pointed out the many factors inducing sulphur dioxide injury susceptible to plants and the effects of sulphur dioxide on animals with varying degree of exposure [15]. J. Heyder et al., concluded on health effects of sulphur as a major environmental pollutant and the harmful effects of acidic aerosols [16]. C. J. Badenhorst reviewed on the occupational health and risks with exposure to sulphur dioxide. He studied and proposed ways for protection against the various issues on health regarding it [17]. Rahila Rahman Khan and M.J.A. Siddiqui studied on the hazardous effects of particulate matters (PM), sulphur dioxide and nitrogen dioxide on human health [18]. Wondyfraw M. studied on the mechanisms and effects of sulphur dioxide with respect to Acid Rain. He observed how the other gases oxides reacts with sulphur dioxide in water, gases or fine particles [19]. The biochemical effects on plant metabolism as a result of sulphur dioxide was analyzed by S.S Malhotra and D. Hocking. They concluded the ability of SO_2 to act as both reducing and oxidizing agent cause the biochemical effects [20].

S.K. Padhi et al., studied on the effects of sulphur dioxide on growth and photosynthetic capacity of plants taking tomato as a model plant [21]. The effects and consequences of acid rain, as due to sulphur dioxide pollution was studied by Anita Singh et al. They analyzed acid rain effects on constructions and lower groups of plants and the necessity measures for its control [22]. A.K. Dwivedi and B.D. Tripathi studied and concluded the presence of high concentration

of sulphur dioxide and particulate matters in areas of coal industries and its effect on the distribution of plants [23]. S. Zandaryaa and A. Buekens reviewed on the control of sulphur oxides. He further suggested the reduction of SOx emissions through the use of clean fuels and desulfurization techniques [24].

4. SCENARIO IN INDIA

The present scenario in India opts for urgent protocols and action in regards to the emission of sulphur dioxide. There has been a major issue of ailments and diseases amongst the greater population with an estimation of 1 of 2 people with respiratory disease. There has been reports of increased in cases of stroke, cancer of the lungs and even premature death. The 'Taj Mahal' in Agra District of Uttar Pradesh, which is enlisted as one of the greatest masterpieces, a UNESCO World Heritage site, has also been a victim to this pollution, as the color of the white marble of which it was made, shows visible signs of decolorization. According to a recent report in 2019 by NASA, India ranks first with total 21% of the anthropogenic sulphur dioxide emission globally with Russia and China in the second and third places respectively. However, the total decline of 6% was estimated in 2019 which is the lowest drop in four years (source: Greenpeace India and Centre for Research on Energy and Clean Air, CREA). The condition is surprising with the fact that the reports in the last decades had shown China being at the top. This has called for an alarming situation of a possible diseases outbreaks and hazardous environmental toxicity in the nearest future. Main hotspots are Mumbai-Pune, Bangalore-Chennai, Gujarat, Gurgaon- Delhi-Meerut industrial regions. The main reason for this tremendous sulphur dioxide content could be the excessive used of coal generated thermal plants and lack of flue-gas desulfurization (FGD) technology. The Ministry of Environment, Forest and Climate Change (MoEFCC) had introduced in 2015, limitations on the emissions of sulphur dioxide for the coal powered plants in the country. However, most power plants till to this day, fails to install FGD units [25]. Modern equipments like that of the sulphur dioxide analyser and Differential Optical Absorbance Spectroscopy (DOAS) should be considered preferably to estimate the sulphur content in air so as necessary steps for its control could be taken based on the sulphur standards.

5. CONCLUSION

Sulphur dioxide (SO_2) is an important constituent of earth's atmosphere with a desired proportion of about 0.0001% by volume, a relatively small amount necessary for maintaining life on earth. However, the exceeding presence of this toxic gas tends to destroy lives as well, thus profound steps to check this tremendous emission of sulphur dioxide is the need of the hour. Sulphur gases tends to hamper the neurological aspects causing behavioural changes other than causing chronic respiratory problems and immune destructions in man. Green house effects, global warming, acid rain are conditions cause by air pollution with adverse environmental affects. From various literature sources, one could possibly visualize the detrimental effects of sulphur dioxide as the major air pollutants and its consequences on human, plants and even constructions. With respect to addressing the present situation, it is mandatory to put forward steps both individually and through legislations to reduced sulphur dioxide emission by modern applications in techniques and equipments to promote better air quality for the general good.

CONSENT

It's not applicable.

ETHICAL APPROVAL

It's not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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