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Result Analysis of Pollutants in Kankra Sewage

[1]Nihar Hirpara, [2]Manoj Gundalia, [3]Helly Mehta

[1,2,3]Chhotubhai Gopalbhai Patel Institute of Technology, Uka Tarsadia University, Bardoli, Gujarat, India

***Abstract* - The World Health Organization (WHO) and its member states strive to ensure universal access to safe drinking water regardless of developmental or socioeconomic status. WHO is tasked with proposing regulations and recommendations concerning global health issues. Hydrogen sulfide, a colorless gas with a rotten egg odor, is detectable at low concentrations and occurs naturally in various environments including crude petroleum, natural gas, and volcanic gases. Industrial processes and bacterial decomposition also contribute to its presence. Hydrogen sulfide is utilized in sulfur production and can be released into the air, water, and soil, persisting in the atmosphere for up to 42 days. Exposure can occur near industrial facilities or agricultural sites with manure storage. Workers in certain industries are particularly at risk. Human studies indicate respiratory and nervous systems are most vulnerable to hydrogen sulfide toxicity, with symptoms ranging from irritation at low concentrations to respiratory distress or loss of consciousness at high concentrations. Long-term effects may include cognitive and motor impairments. Therefore, mitigating exposure to hydrogen sulfide is crucial for public health.**

Keywords: Pollutants, Kankra Sewage, Result Analysis, World Health Organization, WHO, health issues.

I. Introduction

Pollution, as defined by the World Health Organization, involves the introduction of harmful substances into the environment, adversely affecting ecosystems, living organisms, and overall environmental health. It manifests in various forms, including air, water, soil, and noise pollution, stemming from human activities like industrial processes, transportation, agriculture, and improper waste disposal. These pollutants pose significant risks to human health, wildlife, and environmental balance, leading to issues such as respiratory problems, ecosystem disruptions, climate change, and resource depletion. Mitigating pollution is vital for preserving the planet's health and ensuring a sustainable future.

There are three primary classifications of pollution based on affected elements: air, water, and soil pollution. These pollutants, whether intentional or unintentional, profoundly impact daily life.

Water pollution, particularly from urban sewage, presents a pervasive environmental challenge with substantial threats to ecosystems, public health, and aquatic life. As urbanization accelerates globally, the discharge of untreated or poorly treated sewage into water bodies becomes increasingly concerning. Urban sewage is a complex mixture of domestic, industrial, and commercial effluents containing various contaminants like pathogens, nutrients, heavy metals, and chemicals. When left untreated, it contaminates surface waters, groundwater, and coastal areas, posing risks to human health and ecosystems.

The impact of urban sewage on aquatic ecosystems is significant, leading to elevated nutrient levels, harmful algal blooms, oxygen depletion, and biodiversity loss. Industrial effluents further exacerbate the problem by introducing toxic substances into water bodies. Addressing this issue requires not only wastewater treatment but also effective waste management systems and regulatory frameworks. Sustainable urban development practices and innovative wastewater treatment technologies are essential for mitigating water pollution from urban sewage.

Understanding the complexity of urban sewage-induced water pollution is crucial for developing comprehensive strategies to address this escalating problem. By implementing sustainable practices and advanced technologies, we can promote the coexistence of urban areas and aquatic ecosystems while safeguarding environmental and human health.

1.1 Economic Development and pollution

Economic development and pollution form a complex interplay in modern society, posing a significant challenge for policymakers globally. As nations pursue economic growth, they must navigate the delicate balance between prosperity and environmental sustainability. This discussion explores this intricate relationship, focusing on key factors, challenges, and potential solutions. [1]

Economic development, characterized by sustained growth in GDP, income, and employment, has lifted many out of poverty but has also spurred pollution. Industrialization, a major driver of economic progress, emits pollutants into air, water, and soil, contributing to climate change and hazardous waste. Urbanization, another aspect, concentrates populations,

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escalating pollution through increased resource demand and industrial activities.

While economic growth exacerbates pollution, poverty also induces environmental degradation as impoverished communities resort to unsustainable practices. Balancing economic development with pollution control necessitates a holistic approach, with sustainable development principles guiding policies. Encouraging green technologies through financial incentives and international collaboration, as seen in agreements like the Paris Agreement, are vital. Public awareness and participation further enhance sustainable development efforts, fostering a harmonious coexistence of economic prosperity and environmental preservation.

II. Problem Statement

Base ideology of going in for this research was to identify what were the base of these pollutants and how can one curb them for the betterment of the society.

Conducting thorough research on a sewage can benefit a large scale of people, society, infrastructure and environment all together. It is estimated that Billions of rupees are being spent each year due to water pollution on health care and environmental degradation. [3]

Hence, it becomes inevitable for us to act on the problem now.

Occupational lung diseases are a global health issue and have been extensively researched. As per the International Labour Organization, a third of the 2.78 million deaths per year on account of occupational diseases and accidents are due to occupational lung diseases and respiratory cancers. Therefore, occupationally related lung diseases are a major source of morbidity and mortality. The common occupational lung diseases include occupational asthma, occupational COPD, pneumoconiosis and pulmonary cancers related to occupational exposure, like asbestos1. The aetiopathophysiology of many occupational lung diseases are well understood and amenable to control using established and effective approaches. Rising urbanization, industrialization, financial constraint and technological developments have resulted in enhanced occupational exposure to noxious substances as well as obstruction in control of well-researched exposures1. [4]

Hydrogen sulfide toxicity is a known risk for individuals working in the petroleum, sewer, maritime, and mining industries. Concern regarding exposure has led to the development of safety precautions and treatment guidelines. The US government imposes safety measures including self-contained breathing masks and exposure time limits to hydrogen sulfide gas. [5] Current treatment methods, however, are not strongly supported by research. Acute exposure to hydrogen sulfide gas still poses a significant life threat. In this report, we discuss a case of a sewer worker exposed to deadly concentrations of hydrogen sulfide. Safety precautions and treatment options available to those exposed to high doses of hydrogen sulfide gas are explored.

III. Present Waste Water Problems

Kristin Svendsen and Kari K. Heldal conducted a study in Hong Kong, collecting 93 measurements of hydrogen sulfide (H_2S) from 56 wastewater works (WWWs) in urban and rural areas. They used direct-reading instruments to measure H_2S concentrations during morning work hours, assessing factors like task type and flushing extent. H_2S, a dense, toxic gas with a rotten egg smell, corrodes infrastructure and jeopardizes wastewater treatment efficacy. Control measures are crucial for infrastructure longevity and worker safety, as H_2S levels above 500 ppm can be lethal in confined spaces. Sulfide exists in wastewater in various forms depending on pH, primarily originating from anaerobic organic matter decay. Predicting sulfide production aids sewer management, as shown in a study conducted in Gold Coast, Australia, which used dynamic models to optimize oxygen injection for sulfide control. [6] Septic conditions in wastewater collection systems foster H_2S formation, particularly in warm climates with low flow velocities. Industrial and domestic wastewater naturally contain sulfur compounds, exacerbating sulfide accumulation.

$$SO_4\ 2- + \text{Organic matter} \longleftrightarrow H_2S + CO_2$$

3.1 H_2S

Sulfur-related challenges in wastewater management, notably hydrogen sulfide (H_2S) presence, present significant hurdles for treatment facilities. [7] H_2S, a byproduct of anaerobic microbial activity in treatment processes, causes foul odors and poses health risks to workers, leading to respiratory issues and infrastructure corrosion. Industrial discharges and improper disposal of sulfur-containing substances exacerbate sulfur pollution. Formation of sulfate in wastewater, originating from industrial discharges or natural sources, increases water salinity, impacting aquatic ecosystems. [8] Addressing these issues requires multifaceted strategies, including advanced treatment technologies to minimize H_2S production, stringent control of industrial discharges, and public education on responsible waste disposal practices.

Together with nitric oxide (NO) and carbon monoxide (CO), hydrogen sulfide (H_2S) is now recognized as a vital gaseous transmitter. The ubiquitous distributions of H_2S-

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producing enzymes and potent chemical reactivities of H_2S in biological systems make H_2S unique in its ability to regulate cellular and organ functions in both health and disease. Acting as an antioxidant, H_2S can combat oxidative species such as reactive oxygen species (ROS) and reactive nitrogen species (RNS) and protect the skin from oxidative stress. The aberrant metabolism of H_2S is involved in the pathogenesis of several skin diseases, such as vascular disorders, psoriasis, ulcers, pigment disorders, and melanoma. Furthermore, H_2S donors and some H_2S hybrids have been evaluated in many experimental models of human disease and have shown promising therapeutic results. In this review, we discuss recent advances in understanding H_2S and its antioxidant effects on skin pathology, the roles of altered H_2S metabolism in skin disorders, and the potential value of H_2S as a therapeutic intervention in skin diseases.

IV. Sampling and Laboratory Testing

4.1 Sampling

Water sampling, a crucial aspect of testing, must be done according to standards and under rigorous observation. Here, grab sampling method is used to collect samples at proposed locations. Other methods include composite and integrated sampling, which in this location was not possible due to location abnormality.

4.2 Laboratory testing

Testing of samples is carried out at *Pollucon Laboratories PVT LTD., Surat* which is a government certified laboratory and is at top position in its field of testing. Testing was done by Mrs. H. T. Shah (MTech in Environment/Lab manager) under supervision of Dr. Arun Bajpai (PhD in Waste water, IIT Roorkee) which is quality control head and Managing director at Pollucon Laboratories.

Sulphate analysis was done according to IS 3025 (Part-24) method which is standard for Indian Rules and regulations. Potassium and Phosphorous are tested using APHA 3111-B and APHA 4500-PC methods respectively. Detailed procedure of all of these methods can be found in the link given in the references part of this report.

Ethics in laboratory testing are paramount, ensuring accuracy, reliability, and respect for individuals. Upholding ethical standards involves transparency in procedures, informed consent, and confidentiality. Ethical conduct fosters trust in results and promotes integrity in scientific research, safeguarding both patients and scientific integrity.

Figure 1: APHA 4500-PC analyzer

V. Results

Testing of all water samples collected shows some abnormalities in the last collected sample. Amount of sulfur was found beyond three times the allowable limits according to *Indian Standards of discharging Waste water into any water stream-2009*. Such results needs immediate attention of administrative officers as it can get lethal to humans as well as surroundings.

It is clearly seen in the below chart that there is a steep spike in sulphates in 4th location, where phosphorous and potassium is seen on a gradual incline. There for, a theory of production of H2S gas is created which causes certain problems in some areas, specifically Althan area of Surat, Gujarat, India. We will discuss in depth about these issues in next chapter.

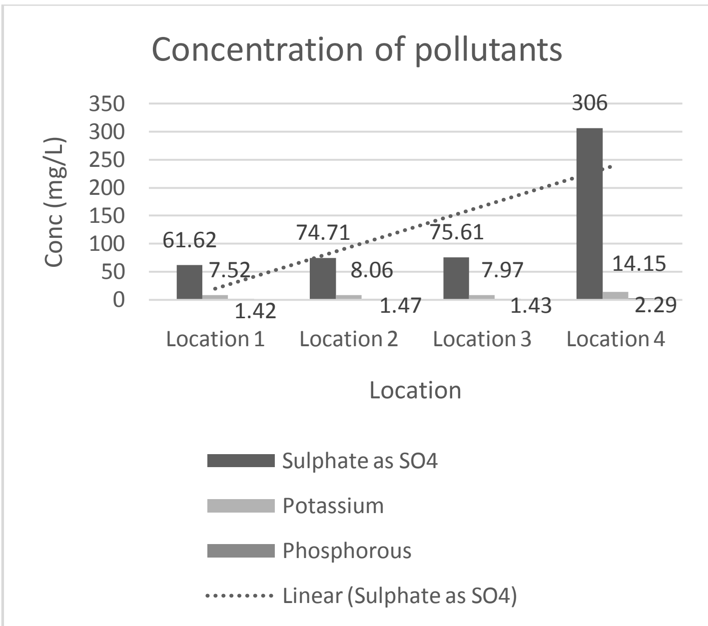

Figure 2: Concentration of pollutants

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VI. Impact of H_2S on Environment

One of the primary consequences of sulfur emissions is acid rain, which occurs when sulfur dioxide and nitrogen oxides react with atmospheric moisture. Acid rain poses a threat to ecosystems, forests, and aquatic environments. It can acidify soil, making it less suitable for plant growth, and acidify water bodies, causing harm to aquatic life. Acid rain's detrimental effects extend to the corrosion of buildings and monuments, impacting cultural heritage.

In addition to acid rain, sulfur compounds released into the atmosphere contribute to air pollution. Sulfur dioxide can irritate the respiratory system in humans and animals, leading to respiratory problems and exacerbating pre-existing conditions such as asthma. The deposition of sulfur compounds can also contribute to the formation of fine particulate matter, which poses health risks and degrades air quality.

6.1 Generation of H_2S and other gases

H2S is produced during the anaerobic decomposition of organic matter in sewage. In the absence of oxygen, sulfate-reducing bacteria thrive and metabolize organic compounds, releasing hydrogen sulfide as a byproduct. This gas not only produces a foul odor characteristic of sewage but also poses environmental and health risks.

Apart from H_2S, other gases such as methane (CH_4) and carbon dioxide (CO_2) are generated during sewage treatment processes. Methane, a potent greenhouse gas, contributes to climate change when released into the atmosphere. While carbon dioxide is a natural byproduct of microbial activity during sewage treatment, excessive emissions can contribute to global warming.

The environmental implications of these gases extend beyond air quality concerns. H_2S, in particular, can corrode metal structures and equipment, posing challenges for wastewater treatment facilities. Additionally, the release of foul odors can lead to community complaints, affecting the quality of life for nearby residents.

Hydrogen sulfide, as said earlier can cause tremendous effect on environment as well as human health if not controlled. Diseases like Dermatitis, red eyes, sore throat, breathing problems, patchy black skins, etc are some of the major problems caused by hydrogen sulfide.

6.2 H_2S in aqueous solution

Hydrogen sulfide, which is weakly acidic when dissolved in water, is involved in a series of chemical reactions in the pipeline. The chemical reactions are:

H_2S dissolution

$$H_2S(g) \longleftrightarrow H_2S(aq)$$

H_2S dissociation

$$H_2S(aq) \longleftrightarrow HS^-(aq) + H^+(aq)$$

HS- dissociation

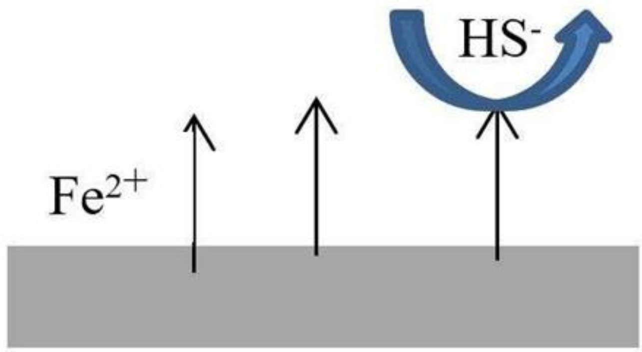
$$HS^-(aq) \longleftrightarrow H^+(aq) + S_2^-(aq)$$

H_2S Reduction

$$2H_2S(aq) + 2e^- \longleftrightarrow H_2(g) + 2HS^-(aq)$$

FeS formation by precipitation

$$Fe(s) + S_2^-(aq) \longleftrightarrow FeS(s)$$



VII. Conclusion

The release of H_2S into the atmosphere, often stemming from industrial processes, anaerobic decomposition in sewage, and certain natural sources, contributes to air pollution with implications for both environmental and human health. Inhalation of H_2S can lead to respiratory irritation, nausea, and, at higher concentrations, serious health issues or even fatalities. While human exposure is a critical concern, the impact of H_2S on the broader environment is equally significant.

One of the prominent consequences of H_2S emissions is its role in the formation of acid rain. When H_2S reacts with atmospheric oxygen, sulfur dioxide (SO_2) is produced, and subsequent reactions in the atmosphere lead to the formation of sulfuric acid (H_2SO_4). Acid rain poses a serious threat to ecosystems, corroding soil and water bodies, disrupting nutrient cycles, and adversely affecting plant and aquatic life. Forests and aquatic habitats are particularly vulnerable, and the long-term consequences of acid rain can be observed in the depletion of biodiversity and the degradation of sensitive ecosystems.

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Furthermore, H_2S has a corrosive impact on infrastructure, particularly in industrial settings and wastewater treatment facilities. The gas, known for its ability to corrode metals, can lead to structural damage, affecting the integrity of pipelines, equipment, and buildings. This corrosion not only poses a financial burden in terms of repair and maintenance but also compromises the safety and efficiency of industrial processes.

VIII. Recommendation

Though this report strongly supports the theory, it is highly recommended to test the air quality near the banks of Kankra sewage to accurately prove and suggest preventive remedies and measures. Air sampling is a tricky process which requires experts and high-end equipment to collect samples, which unfortunately was not present to us.

Air pollution now and will remain a major issue to fight for atleast several years to come. Preventing air pollution today will make a better future for upcoming generations to breath healthy and safe air.

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AUTHORS BIOGRAPHY

Nihar Hirpara,
Department of Civil Engineering, CGPIT, Uka Tarsadia University, Bardoli, Gujarat, India.

Manoj Gundalia,
Associate Professor and Head, Department of Civil Engineering, CGPIT, Uka Tarsadia University, Bardoli, Gujarat, India.

Helly Mehta,
Associate Professor, Department of Civil Engineering, CGPIT, Uka Tarsadia University, Bardoli, Gujarat, India.

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