International Journal of Scientific Research in Science, Engineering and Technology

Print ISSN - 2395-1990
Online ISSN : 2394-4099

OPEN ACCESS

Available Online at : www.ijsrset.com
doi : https://doi.org/10.32628/IJSRSET

Removal of Heavy Metals from Waste-water of Sugar Industries, Using Low Cost Natural Adsorbents

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ARTICLEINFO

Article History:

Accepted: 25 Nov 2023
Published: 04 Dec 2023

Publication Issue
Volume 10, Issue 6
November-December-2023

Page Number
380-386

ABSTRACT

Heavy metals are observed to be the major toxic pollutants and responsible for severe adverse effects upon the human health. Heavy metals are very often released into the open drains along with the waste water after the various chemical processing units of the industries. Some of the heavy metals generate the very adverse effects on human health due to their acute exposure existing nearby areas' people through air, water as well as food chain.

The existing conventional methods for the treatment of heavy metals have their own limitations due to high cost and ineffectiveness along with second effect causers too. Natural adsorbents are used as an attractive cum potential alternative to their conventional methods. It is also considered as an economic solution to problem of the high cost treatment problem.

Today, sugar industry is considered as one of the most polluting industries to the environment. As, it produces a large amount contaminated waste water which is used and then released into the open drains without proper treatment, reason for such practices is the high cost of proper treatment of industrial waste water. That's why, natural low cost adsorbents can play a vital role to maintain a control over the contaminated untreated waste water generating or releasing from various units of the chemical processing in sugar industries.

Keywords : Heavy Metals, Major Toxic Pollutants, Chemical Processing, Sugar Industries

INTRODUCTION

In olden days, personal needs of human beings were very limited, he could satisfy his day-to-day wants/needs using very little amount of natural resources. But today, everywhere there is a bigger demand of natural resources especially energy like in transportation, agriculture, business, telecommunication, domestic requirement etc. as each of us knows that most of energy come from fossil fuels like oil, coal and natural gas etc. They increase the CO2 concentrations and other greenhouse gases in the existing atmosphere up to a large extent. Eventually, there will certainly be a big role of these

gases in environment pollution, global warming and environmental crisis. As reported by several dedicated researchers that the natural crisis is not only the outcome of natural calamities but also is the consequence of lack of good govt planning, increase in no. of industries and human waste and above all lack of public awareness towards environmental conservation.

Water has always been considered as the most precious gift of supreme power i.e. God/Almighty. The existence of whole universe is dependent on water. Due to this reason, it is called that water is life. The primary reason is that every living element on earth consists of approximately 65% to 70% of water in their body. We cannot think of life without water whether it is plants, animals, humans and other living things. The releasing of untreated effluents regularly from various industries in water bodies begets the problem of the accumulation of toxic heavy metals in water bodies. Heavy metals are known as not bio-degradable and often tend to augment in living organism and causing cancerous diseases and various types of disorders in human and animals since effluents from large number of industries like paper industries, sugar industries etc carry toxic metals like lead, Hg, Cd and As etc.

The Concept of the Water Pollution

Water pollution is an alarming world-wide phenomenon. As we know that chemically, pure water is the collection of H2O molecule. When there is any change in the structure of water is considered as water pollution. Ground water is the dominant resource in rural area especially in India to meet the drinking needs of the people. But now-a-days, the shallower wells are found to be more affected by fluoride, arsenic, salt, iron or microbial contamination. The over-use of pesticides and chemical in agriculture is considered as main cause of ground water pollution in rural areas.

Water pollution pinpoints to the presence in water, of some foreign substances or impurities (organic, inorganic, radiological or biological) in such quantity so as to constitute a health hazard by lowering the beings or other living creatures or to the industrial operations or the structure of water itself. In short, any alteration in the physical, chemical or biological properties of water as well as any impurities due to any foreign substance causing a health hazard and eventually results in a decrease in the utility of water is water pollution.

Objectives of the Study

1. To understand the concept of environmental pollution
2. To highlight the major polluting industries in India
3. To highlight the concept of water pollution
4. To mention the sources and effects of water pollution
5. To highlight the concept of sugar industrial pollution
6. To pinpoint the sugar industry pollution and maximum permissible limits
7. To mention the ways to control waste water pollution via natural adsorbents

The Concept of Environmental Pollution

Environmental pollution is one of the major and serious threats now-a-days and often defined as “the contamination of physical and biological components of the earth to such an extent that normal environmental processes are adversely affected.” The contamination of the earth creates the serious environmental problem. All is due to human beings’ avarices as well as the lifestyles and gradually has created and destroyed life cycle on earth. This has affected our health a lot and the future too through mixing the harmful pollutants with our environment and now degrading the environmental quality. No one will be able to survive comfortably on this planet

if environmental problems exist as usual. Now, time has come to ponder that healthy environment is the assets for existence of life.

17 Categories of the Major Polluting Industries

Aluminium Smelter	Dyes and Dye Intermediates	Petrochemicals	Thermal Power Plant
Caustic Soda	Fertilizer	Drugs and Pharmaceuticals	Zinc Smelter
Cement	Integrated Iron and Steel	Pulp and Paper	
Copper Smelter	Tanneries	Oil Refineries	
Distilleries	Pesticides	**Sugar**	

Source- *Central Pollution Control Board, 2019*

Sugar Industrial pollution is considered as outcome and the result of the manufacturing process or production of energy by burning gas, coal waste or the like. In recent years, environmental degradation has become a problematic concern worldwide. It covers soil erosion, desertification, air pollution, shrinking of ozone layer, global warming and deforestation etc. Today, sugar industry is at the cross roads due to huge environmental pollution worldwide. Brazil is at the top in the production of sugar cane. Major Sugar manufacturers worldwide are China, India, Thailand, Pakistan and Mexico. The Indian sugar industry is considered as a key driver of rural development and boosts up the India's economic growth.

Sugar industry is seasonal and periodic in nature ie 4-5 months' functioning period per year/ in a season. Air and water pollution due to sugar cane industries can easily be observed and measured through recoding the data during crushing and non-crushing periods of sugar mills. Sugar factories release a large amount of gases and affect the human and animal population along with the plants grown near about the sugar production factory area. The construction of irrigation sites, roads and the levelling of land release higher dust storms in the air and always have an unhealthy effect on labour class in sugar production factory and people living nearby areas of sugar industries.

Much amount of water is utilized in the sugar industries as a result, sugar industries discharge large amount of waste water containing different chemicals which are normally mixed during the processing. Waste water is usually generated through different process in sugar industries during its crushing period from different sections like mill house, boiling house water, waste water from boiler blow down, excess condensate water, condenser cooling water, soda and acid wastes. The waste water and gaseous effluents produced from sugar industry have acute adverse impact on the eco-system and environment due to their high BOD load and toxic constituents and have an adverse impact on environment through the loss of natural habitats, heavy use of agro-chemicals, discharge and runoff of polluted effluent and air pollution. All these lead to the degradation of soil, air waste and wildlife too.

Stepping together with the developed countries regarding the development of economy is a big challenge before us. Along with it on the other hand, to maintain the qualities of water, air and land /soil through the various treatment strategies to different kinds of pollutions generating from sugar industries also a big problem. This paper pinpoints on the complete picture of sugar industries, dealing with air and noise pollution and their treatment strategies.

Effects of Water Pollutants

Pollutants	Effects
1. Organic wastes	Promote decomposition, causing deoxygenation and death of animals, anaerobic (oxygen hating) bacteria produce foul smelling gases, scum and sludge form and render water unfit
2. Pathogens	Disease of human and domestic animals
3. Phosphates and nitrates in fertilizers and detergents	Promote algal growth, causing deoxygenation and death of animals, decay of dead algae produces foul gases, silt and decaying matter may fill up the water body.
4. Toxic chemical (Hg, As, Pb, Cyanide)	Reach human and animals bodies through poisoning, disease and death as they accumulate in bodies
5. Oil	Kills animals by catching fire and by reducing oxygen and plant life
6. Radioactive wastes	Reach human and animals bodies via food chain and cause death
7. Solid particles	Cause turbidity that reduces light for photosynthesis and this causes loss of water life
8. Heat	Warm water holds less O_2 insufficient to support life
9. Non-degradable pesticides	Reach human body via food chain, affect nervous system
10. Broad spectrum pesticides	Cause large scale destruction of aquatic life
11. Fluorides	Fluorosis
12. Dyes: Fe and Cr compounds	Change colour of water
13. Fe, Cl, Mn, HC, Phenol	Make water distasteful
14. Cl, H_2S, NH_3	Impart unpleasant ordour to water
15. Detergent, Soaps	Cause from formation
16. Corrosive materials	Spoil waste water treatment plants
17. Organic sulphur	Hampers nitrification

Source-Foundation of Environmental Studies, *Galgotia Publication PVT Ltd, New Delhi*

Pathological Effects of Heavy Metal Water Pollution on Man

Metal	Pathological Effects
1. Mercury	Foetal disorder
2. Lead	Neurological disorders, kidney damage, gastrointestinal, pulmonary disorders, genetic damage, brain, liver and kidney damage,

	anemia, vomiting and loss of appetite
3. Arsenic	Disturbed peripheral circulation, mental disorders, liver, cirrhosis, lung cancer, ulcers in gastrointestinal track, kidney damage
4. Cadmium	Bone deformation, Kidney damage, injury to central nervous system, liver, growth retardation
5. Copper	Sporadic fever, Hypertension
6. Barium	Excessive salivation, vomiting, diarrhea, paralysis, colin pain
7. Zinc	Renel damage, cramps
8. Chromium	Nephritis, gastrointestinal ulceration, cancer, disease of central nervous system
9. Cobalt	Diarrhea, low B.P., lung irritation, bone deformities, paralysis

Source- Environmental Studies, *S.K. Kataria and Sons, Publishers and Distributors, Delhi*

The Ways to Control Waste Water Pollution via Natural Adsorbents

Adsorption refers basically a mass transfer process. In adsorption process, a substance is transferred from the liquid phase to the surface of a solid and becomes bound by physical and/or chemical interaction. Adsorption process is mainly due to attractive interaction between a surface and the group being an adsorbent. Based on the types of intermolecular focus adsorption are of the two types:

Physical Adsorption – It is a process in which binding of adsorbent on the adsorbent surface is caused by vander wools force of attraction. It occurs in any solid/ liquid or solid/gas system.

Chemical Adsorption- it is a process in which strong interaction b/w the adsorbent and the substrate surface which create new types of electronic bound (covalent, ionic). It involves a chemical reaction/w the adsorbent and the adsorbent.

Characteristics of Adsorbent

- An adsorbent should have high selectivity to facilitate quick separation.
- It involves favorable transport and kinetic characteristics.
- It involves thermal and chemical stability and it also involves mechanical strength.
- An adsorbent has regeneration capacity,
- An adsorbent should have high adsorption capacity, long life and low cost.

Why to use low cost natural adsorbents?

The treatment facilities of waste water are difficult and also expensive. So, there is an increased demand for the innovative, low maintenance and energy efficient technology for waste water treatment. Amongst waste water treatment technologies, adsorption is as the most versatile process. Adsorption process appears to be more suitable because of its some of the following advantages:

- Low operating cost
- Metal selective process
- Associated with high metal removal capacity
- No generation of toxic sludge in this treatment, it means lesser secondary effluent
- Easily available economical, eco-friendly and highly effective

The adsorbents often used are mostly natural modified adsorbents, agricultural waste materials,

industrial by products waste and many micro-organisms spices.

The factors associated with Adsorption

The effect of the following parameters within the respective ranges are usually studied such as: temperature, pH, initial concentration of adsorbent, contact time and dose of adsorbent.

Classification of Adsorbents

Adsorbents are classified on two bases –

1. **On the basis of their availability-**

Natural materials

Industrial/agricultural/domestic waste or by-products, Synthesized products

2. **Depending on their nature**

An application of Bio-sorption using fungi, yeast and bacteria for the removal of organic pollutants

But low cost natural adsorbents may be divided in the following the six groups:

A) House hold and agricultural wastes – wheat bran, onion, fruits peels, rice straw, almond shell, apricot shell and banana peel
B) By-products of Industrial waste - fly ash, blast furnace, sludge, slag, bagasse , saw dust, waste material of tea factories and beer brewery waste
C) Sludge from waste water
D) Sea materials- chitosan and sea food processing wastage, sea wood and algae etc peat moss
E) Soil and ore materials- clays, zeolites, sediment and soil and ore materials
F) Emerging low cost adsorbents – it is related to the use of innovate materials such titanium dioxide.

Treatment of Industrial Effluents

There exist multiple types of treatment processes for waste water having contamination with heavy metals. Normally, effluents discharged from sugar industries can be treated by three conventional methods viz chemicals, physical and biological methods, which can be further subdivided as follows

Treatment methods for Industrial waste- water

- Chemical Method
- Physical Method
- Biological Method

Chemical Methods

1. Oxidation
2. Electrolysis
3. Ozonation

Physical Methods

1. Reverse Osmosis (Membrane treatment)
2. Filtration
3. Coagulation/ flocculation
4. Adsorption

Biological Methods

1. Micro organisms
2. Enzymes

But now-a-days, adsorption method has become one of the main alternative treatments. In recent years, the researches for low cost adsorbents that have metal binding capacities, have raised. The main target of the present endeavor is to use the low cost natural adsorbent for the treatment of waste water which is usually discharged from the various industries especially due to economically feasible and eco – friendly technology.

Methodology – The removal methods that are used as follows-

A. In one set of experiment, effluents from sugar industry are run through column packed with natural adsorption.
B. In the other set, the effluents from sugar industry are simply agitated with known weights of the natural adsorbents.

Low cost adsorbent--------->Dried ------ > Grind------- ---- > Agitated with waste water ------ > Heavy metals adsorb by adsorbents

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