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Environmental Hazards Caused by Cement and Fertilizer Industries in the Iskandarabad Region District Mianwali

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Abstract: World has undergone the rapid industrial growth in the last few decades. These industrial changes have made today's life easier and more comfortable than ever before. No doubt, this industrial revolution created jobs opportunities for the unemployed youth. On the other side of the mirror, this industrial revolution also brought a storm of pollution that has ruined the environment of our planet. Effects of this industrial revolution are also felt in Pakistan. Unfortunately, due to severe energy crisis desirable results can't be achieved in Pakistan. Cement industry is one of the leading industries in the Pakistan. Pakistan has inexhaustible reserves of clay and lime. There are 24 cement plants are working in Pakistan. Pakistan is the 14th largest cement producing country in the world. It is amongst the top five cement exporting countries in the world. Pakistan is an agricultural based country. Consumption of fertilizer shows country's progress in agricultural sector. Mianwali is a district located in northwest of Punjab. It has large deposits of gypsum, silica, clay and mines of coal and salt. That's why, in 1952 government of Pakistan has established an industrial estate naming Iskindarabad industrial estate in Mianwali. Maple Leaf Cement Factory is working since 1955 and Pak American Fertilizer Factory is working since 1958. These factories are creating some serious environmental issues in the Iskindarabad region that demand attention of the higher authorities. Samples of soil are collected from the nearest inhabited area. Water samples are collected from the drains of both factories and ground water from the nearest vicinity. Parameters of chemical oxygen demand (COD), total dissolved solids (TDS), total suspended solids (TSS), PH level and electrical conductivity are tested. It is found that PH level is showing normal character. Chemical oxygen demand (COD) and Electrical conductivity are exceeding permissible limits of WHO. Total suspended solids (TSS) are less than the permissible limits of WHO. Total dissolved solids (TDS) of cement and fertilizer factories is less than the permissible limits while Total dissolved solids (TDS) is above than the permissible limits of WHO. These results show that this water is unhealthy for drinking purposes. X- Ray Fluorescence technique is used for the analysis of soil samples. Concentrations of aluminum, silicon, calcium, zinc, strontium, titanium etc. and their oxides are found. By comparing these concentrations with standard concentration of metals and their oxides in soil, excess of metals make this soil contaminated. Contaminations in water and soil samples are creating some serious environmental hazards in the area.

Keywords: Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), Total Dissolved Solids (TDS), PH (Potential Hydrogen), EC (Electrical Conductivity), X-Ray Fluorescence (XRF)

1. INTRODUCTION

World has undergone a rapid industrial growth in the past few decades. All countries are trying their best for the progress of their industrial sector. Role of industrial sector cannot be denied in the development of any country. It plays significant role in economic stability of any country. Industrial growth has changed human life. Industry of any country is a center of hope for the unemployed workers. Industrial sector of any country absorbs its unemployed youth by increasing their income resources. Industrial sector produces skilled labor of a country that raises their income resources.

With all these benefits there are also some negative impacts of industrialization. The most alarming is the increase in pollution due to different industries. Factories and industries are spreading pollution in all forms water pollution, land pollution and air pollution. Industries are becoming threat for our environment. Industrialization has a major share in increasing global warming. Industrial waste water has chemicals and sludge of heavy metals in it. Unfortunately, this untreated waste water is thrown into streams, lakes, rivers and sea which contaminate their water. This contaminated water is dangerous for the life of water

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creatures. Wastes of factories and industries have toxic chemicals in it. It is disposed of in landfills which contaminate soil. Emission of gases and smoke of factories is responsible for air pollution. This air pollution is increasing global warming. It is also destroying ozone layer. This pollution is becoming the cause of many diseases in human beings and animals.

Cement industries one of the industries that were working at the time of creation of Pakistan. Pakistan has inexhaustible reserves of clay and lime. Pakistan is the 14th largest cement producing country in the world.

Pakistan is an agricultural based country. Fertilizer industry of Pakistan is extremely productive. Pakistan is one of the major exporters of fertilizers of the world. Fertilizer industry plays vital role in the economy of the country.

Mianwali district is located in northwest of Punjab. It is a minerals rich district of Punjab. It has large deposits of gypsum, silica, clay and mines of coal and salt. That's why in 1952 government of Pakistan established an industrial state in Iskindarabad district Mianwali.

A cement manufacturing plant was established with the cooperation of government of Canada that started working in 1955 which is known as Maple Leaf Cement Factory Iskindarabad. Maple Leaf Cement Factory is producing grey cement 3852 k tons per annum and white cement 201.6 k tons per annum.

Pak American Fertilizer Factory which was the first nitrogenous plant in Pakistan that started working in 1958. Now, it is privatized and working as Agritech Limited. Pak American Fertilizer Factory is producing 234 k tons per annum ammonia and 522 k tons per annum urea. Agritech is one of the famous plants of fertilizer production. It produces almost 7% of the Pakistan's total production.

Cement and fertilizer industries are important for any country's progress and development. Both industries are good source of providing employments to the unemployed youth. Cement and fertilizer industries in the Iskindarabad region are producing some serious environmental issues in the vicinity that demands the attention of the concerned authorities.

2. METHODS

- **Study Area:**

This study was conducted in the surrounding area of the Iskinderabad industrial estate. The area of study was a small town "GullenKhel" located in the Mianwali district of Punjab province. It is situated 45 Km on north from the Mianwali city. Approximately at 3-4 Km northwest of GullenKhel Indus River flows near the Kalabagh town. GullenKhel is located adjacent to the Pak American Fertilizer and Maple leaf cement factory. It is populated on both side of the road.

- **Collection of Samples**

Samples of soil and water are collected from different places.

- **Collection of Soil Samples**

Samples of soil were collected at a depth of 12cm to 24cm of the topsoil were collected cross sectional. Three samples of soil were collected near the Pak American Fertilizer while three samples of soil were collected near the Maple Leaf Cement Factory Iskindarabad at the depths of 12cm, 18cm and 24cm. The soil samples location was about 100m from the area of Maple Leaf Cement Factory where populated area starts while the location of the samples of the soil near the Pak American Fertilizer Factory was about 200m away from the factory area where nearest population lives. The soil samples were taken for their physical and chemical analysis. Physical and chemical analysis was done in the laboratory of Institute of Environmental Sciences and Engineering (IESE) of National University of Sciences and Technology (NUST) Islamabad.

- **Sampling of Water:**

Samples of water were collected from different places. One sample of water was collected from the drainage of Maple Leaf Cement Factory. Another sample of water was collected from the ground water of the nearest populated area "Gullen Khel". Similarly two different samples of water were collected from the drainages of Pak American Fertilizer Factory. Another sample of water was collected from the ground water of the nearest populated area "Gullen Khel". We will check the effects of both industries on the ground water of the area. The samples of water were taken for their physical and chemical analysis. Physical and chemical analysis was done in the laboratory of National University of Sciences and Technology (NUST) Islamabad.

- **Tests and Techniques:**

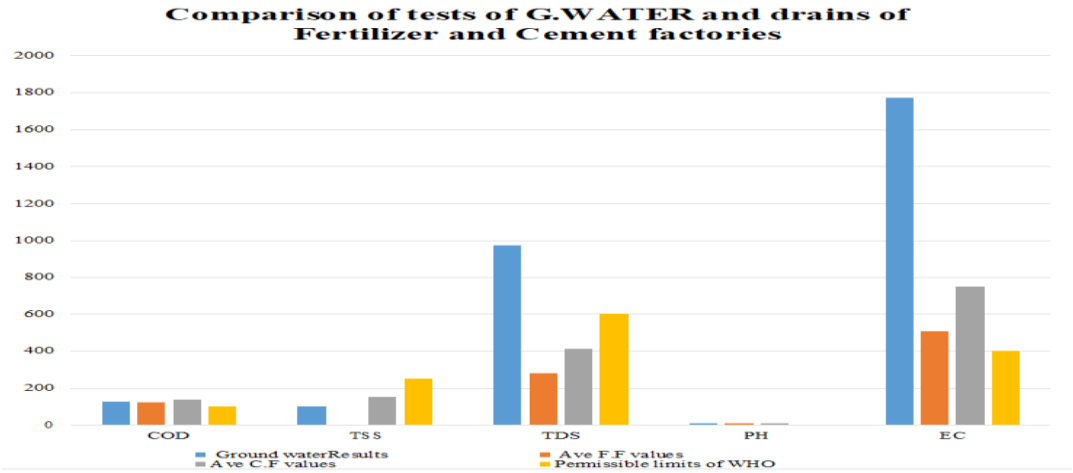
Following tests were done for analysis:

i. Chemical Oxygen Demand (COD)
ii. Total Suspended Solid (TSS)
iii. Total Dissolved Solid (TDS)
iv. Electrical Conductivity (EC)
v. PH Level
vi. Elemental Analysis (EA)

3. RESULTS

- **Results of Water Samples:**
- **Table 01. Results of physical and chemical analysis of samples of water**

Sr No.	Parameters	Units	Averagegrou nd water values	Average F.F.values	Average cement factory values	Permissible limits of WHO
1.	COD	mg/l	125	120	137	100
2.	TSS	mg/l	100	0	150	250
3.	TDS	mg/l	974	279	411	600
4.	PH		7.7	7.3	7.2	6.5-8.5
5.	EC	µS/cm	1771	507	746	400

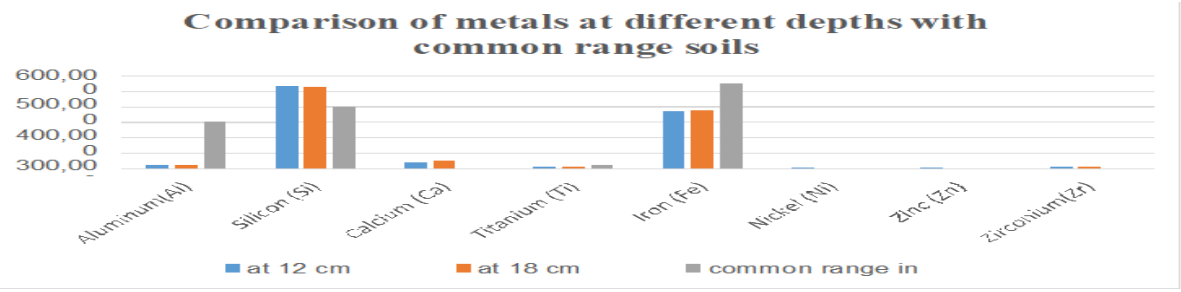


Results of COD, TDS and EC are exceeding the permissible limits of WHO. The results of TSS are below the permissible limits of WHO While PH of the samples is within the limits. That's why ground water is not fit for drinking purposes.

- **Results of Soil Samples (Near Cement Factory):**

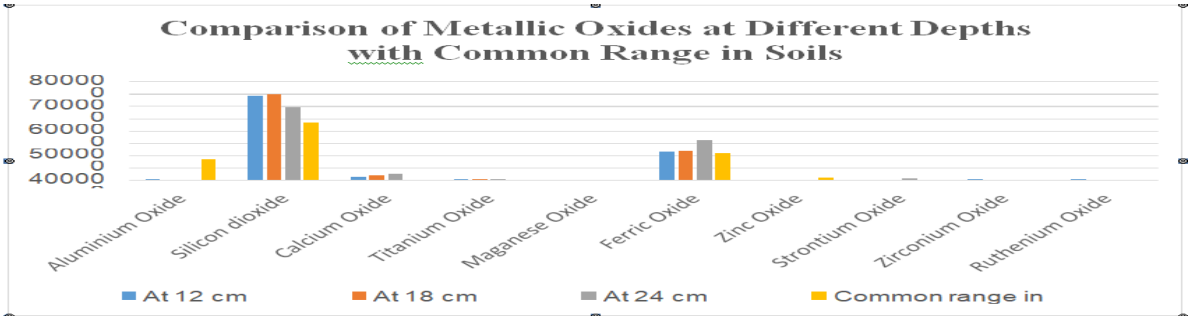
Pure Metals:

Sr No.	Effluents	Units	At 12cm depth	At 18cm depth	Common Range in Soils
1.	Aluminum(Al)	mg/kg	25,283	24,012	10,000-300,000
2.	Silicon (Si)	mg/kg	532,607	527,347	50,000-400,000
3.	Calcium(Ca)	mg/kg	40,819	49,485	400-2500<
4.	Titanium(Ti)	mg/kg	8,995	10,143	170-20,000
5.	Iron(Fe)	mg/kg	368,626	373,552	7,000-550,000
6.	Nickel(Ni)	mg/kg	3,965	----	3-1000
7.	Zinc(Zn)	mg/kg	7,616	----	10-300
8.	Zirconium(Zr)	mg/kg	12,088	12,338	5-1060



Oxides:

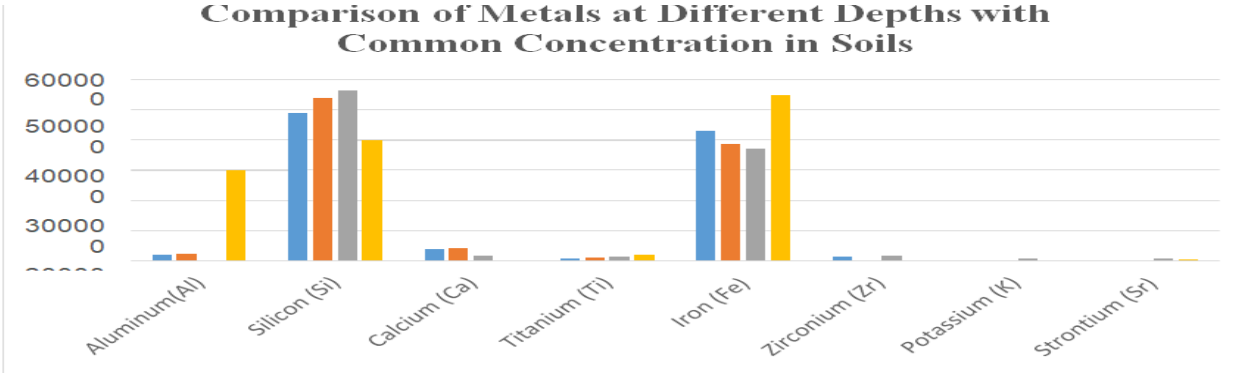
Sr No.	Effluents	Units	At 12 cm depth	At 18cm depth	At 24 cm depth	Common range in soils
1.	Aluminum Oxide (Al2O3)	mg/ kg	12,044	-----	-----	174,000
2.	Silicon dioxide (SiO2)	mg/ kg	687,402	699,376	595,627	471,000
3.	Calcium oxide (CaO)	mg/ kg	30,221	38,333	54,198	1,700
4.	Titanium Dioxide (TiO2)	mg/ kg	7,823	8,565	8,981	0.05-500
5.	Manganese Oxide (MnO)	mg/ kg	2,230	3,369	----	540
6.	Ferric Oxide (Fe2O3)	mg/ kg	234,722	238,308	326,030	1,600-223,000
7.	Zinc Oxide (ZnO)	mg/ kg	2,882	-----	-----	23,000
8.	Strontium Oxide (SrO)	mg/ kg	6,450	6,355	15,166	1,750
9.	Zirconium Oxide (ZrO2)	mg/ kg	7,030	5,693	----	0.1-1000
10.	Ruthenium Dioxide (RuO2)	mg/ kg	9,195	----	-----	0.0004



- **Results of Soil Samples (Near Fertilizer Factory):**

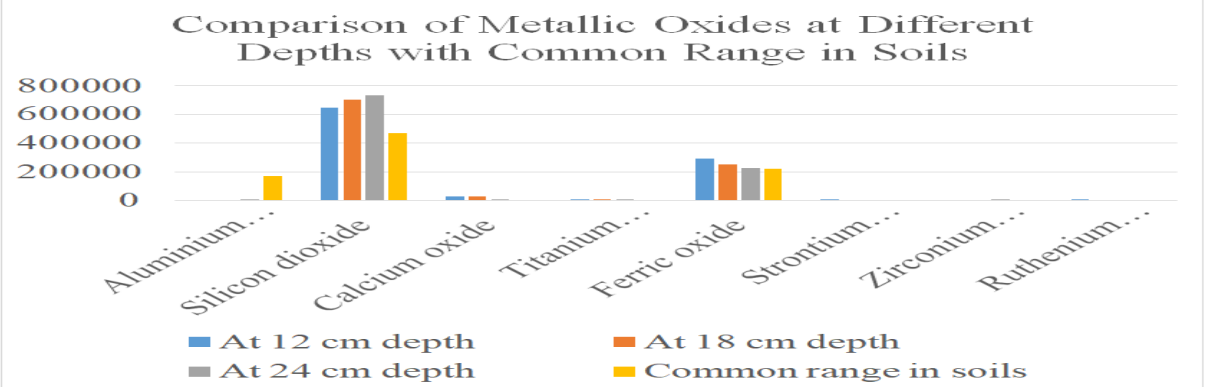
Pure Metals:

Sr No.	Effluents	Units	At 12 cm depth	At 18 cm depth	At 24 cm depth	Common
1.	Aluminum(Al)	mg/kg	19,761	23,708	----	10,000-300,000
2.	Silicon (Si)	mg/kg	491,354	539,401	564,631	50,000-400,000
3.	Calcium(Ca)	mg/kg	38,085	39,939	15,333	400-2500<
4.	Titanium(Ti)	mg/kg	8,403	9,977	12,585	170-20,000
5.	Iron(Fe)	mg/kg	429,587	386,976	372,932	7,000-550,000
6.	Zirconium (Zr)	mg/kg	12,809	----	17,517	5-1060
7.	Potassium(K)	mg/kg	-----	-----	8,713	120-180
8.	Strontium (Sr)	mg/kg	----	----	8,288	8-3120



2.3.2 Oxides:

Sr. No	Effluents	Units	At 12 cm depth	At 18 cm depth	At 24 cm depth	Common range in soils
1.	Aluminum oxide (Al2O3)	mg/kg	----	5,513	11,499	174,000
2.	Silicon dioxide(SiO2)	mg/kg	647,819	699,630	733,816	471,000
3.	Calcium oxide (CaO)	mg/kg	29,011	27,265	8,709	1,700
4.	Titanium dioxide (TiO2)	mg/kg	9,738	9,250	8,671	0.05-500
5.	Ferric Oxide(Fe2O3)	mg/kg	291,895	252,054	225,344	1,600-223,000
6.	Strontium Oxide(SrO)	mg/kg	7,525	6,288	3,243	1,750
7.	Zirconium Oxide(ZrO)	mg/kg	5,276	----	8,718	0.1-1,000
8.	Ruthenium Oxide	mg/kg	8,780	-----	-----	0.0004



Reasons of Soil Contamination and Water Contamination:

World health organization (WHO) has mentioned the permissible limits of different parameters of drinking water. The Values above or below than these permissible limits make water contaminated. The composition of soil is different throughout the world. As above results show that concentration of aluminum, titanium and iron is within permissible limits while silicon, calcium, zinc and zirconium are exceeding the permissible limits. There are some reasons of this excess.

Fly Ash:

A coal combustion product is known as fly ash. It is a set of products that makes up the most plentiful hazardous materials (Schnoor *et al.*, 1995), Fly ash consists of significant amounts of silicon dioxide (SiO2), aluminum oxide (Al2O3), ferric oxide (Fe2O3) and calcium oxide (CaO) etc. Minor elements of fly ash are on coal bed composition but up to hundreds ppm concentrations of arsenic beryllium, strontium, manganese, boron etc. along small concentrations of dioxins and PAH compounds (Sparks, 1975), (United States. Clean Water Act,)

Leakage of poisonous elements of fly ash which can be 100-1000 times greater than the federal standard for drinking water. Maple Leaf Cement Factory is a coal based power plant. That's why; Maple Leaf Cement Factory is continuously producing fly ash. Although factory is using filter bags for controlling this fly ash but some part of the fly ash is still going in the atmosphere which is the main reason of this water and soil contamination.

Waste Water of Cement and Fertilizer Factories:

The waste water of nitrogenous fertilizer plant is the used water of acid wash, overflow of wet scrubbers, leakage of water and acid effluents from storage tanks and boilers. In the production process of ammonia emitted waste water includes ammonia, amines and methanol. Ammonia NH3, Carbon dioxide CO2 are present in the waste water of urea production. This effluent water is drained from factory which is absorbed by soil and contaminates it. Absorption of this polluted water also contaminates ground water and soil of the surrounding areas.

Emission of Gases through Cement and Fertilizer Factories:

Poisonous gases like carbon dioxide (CO2), carbon monoxide (CO), sulphur dioxide (SO2) and nitrogen dioxide (NO2) are emitted in the production of cement that are all greenhouse gases. Ammonia, natural gas, hydrogen (H2), carbon dioxide (CO2), carbon monoxide (CO) are emitted in the production of urea and ammonia. Occurrence of hydrogen sulfide (H2S) is dependent on the fuel used. Acid rain is caused by sulphur dioxide (SO2). Nitrous oxides react to form HNO3 which is washed out from the atmosphere causing acid rain. This acid rain is ultimately absorbed in soil and contaminates soil and ground water.

Hazardous Materials:

During the manufacturing, storage and transportation hazardous materials are produced in large quantities in both cement and fertilizer factories. For achieving high temperatures of cement kiln, these hazardous materials are burnt in kiln. Remaining materials are usually stored in landfills. If these materials are not managed properly, they will play their part in contamination of soil.

a. Environmental Hazards Caused by Pollution:

Health Hazards:

Some of the heavy metals such as iron, zinc, manganese etc are necessary for the human body in small amounts. But if their concentration increases than the sufficient amount then they cause some serious problems. Causes of heavy metal poisoning are industrial exposure, contaminated water and air, foods and medicines, improperly coated food containers etc.

Diseases of Respiratory Tract:

Quality of air is important for our health. Respiratory system and lungs are effected by the polluted air. Pollutants in the air like metals and radicals can damage the cells of lung tissues. There are also other symptoms like irritation of the airways, coughing, feeling difficulty in breathing and decreased function of lungs. It can worsens the conditions of asthma and emphysema patients. Long term effects chronic respiratory disease and lung cancer. That's why, in highly polluted areas exercise should not be done outdoor.

Heart Diseases:

Environmental features, particularly air pollution produces extra dangers with the consequences of health that are underrated in the Global Burden of Disease (GBD) (WHO 2017). Long term exposure to higher levels of fine particle matter damages vascular function which proceeds to myocardial infraction, arterial hypertension, stroke and heart failure https://www.sciencedirect.com/science/article/pii/S0166248108701788.
http://weppi.gtk.fi/publ/foregsatlas/text/Sr.pdf

Diseases of Gastrointestinal Tract:

Polluted water has harmful health effects such as gastrointestinal diseases and neurological problems. Gastrointestinal infections are viral, bacterial or parasitic infections. It causes gastroenteritis, an inflammation of the gastrointestinal tract which contains small intestine and stomach. Its symptoms are nausea, diarrhea, vomiting and abdominal pain.

Diseases of Kidney Failure:

Human beings and animals consume toxic materials by consuming polluted foods, polluted water and mining and by recycling of batteries and plastics. Kidneys are more exposed to toxicity of heavy metals mostly lead (Pb), mercury (Hg) due to main path of flow from the body http://weppi.gtk.fi/publ/foregsatlas/text/Fe.pdf Various mortal impacts have been narrated in composition of blood, lung and brain depending on the interval and size of the dose http://weppi.gtk.fi/publ/foregsatlas/text/Fe.pdf Long exposure to the polluted water increases the risk of cancer and disorders in kidney, liver and reproductive orders (Managing Coal Combustion 2019).

Skin Problems due to use of contaminated water:

After a long time exposure, heavy metals cause irritations. Everyone has separate reactions to different chemicals. Different types of microorganisms in the water cause skin allergies. Many skin infections are the result of contaminated water. Skin irritation and skin itching are also a result of contaminated water.

Trachoma:

It is an eye infection which is caused by bacterium Chlamydia Trachomatis. It is found in contaminated water. Coarsening of the inner surface of the eyelids is the outcome of trachoma. It causes pain in the eyes, scratching on the outer surface or cornea and eventual blindness. Poor hygienic conditions and sanitation are the reasons of spreading of trachoma. Eye itching and some other eye infections are also the result of water contamination due to heavy metals.

Diseases of nervous system:

Air pollution can affect the nervous system by various cellular, molecular and inflammatory ways. Sometimes, they directly harm brain structures and sometimes cause neurological diseases. Ischemic stroke, multiple sclerosis and PD are the neurological diseases that show a strong link to ambient air pollution. Other diseases of central nervous system cannot be linked with air pollution (Impact of Nano and Bulk ZrO2, TiO2 2013). Pesticides can damage the nervous system. Carbonates and organophosphates in pesticides can cause cancer.

Impacts on Vegetation:

In the production of cement, fugitive dust and some metallic effluents e.g. iron, calcium and the surrounding areas. These dust and effluents settles down on plants and affect their metabolic process. It directly effects the growth and quality of plants. Dust particles effect the accusation of chlorophyll. The concentrated dust particles stop the sunlight from reaching to the leaves. That will decrease the pigment formation. The retardation in chlorophyll synthesis causes premature leaf yellowing and ultimately dropping of stem.

Acid Rain:

Carbon dioxide (CO2), carbon mono oxide (CO), sulphur dioxide (SO2) and oxides of nitrogen (NOx) are emitted in large quantities by cement and fertilizer industries. Acid rain is caused by sulphur dioxide (SO2). HNO3 is formed by the reactions of Nitrous oxides which are washed out through atmosphere by rain. Acid rain occurs due to reactions of these chemicals with water, oxygen and other chemicals. Sunlight stimulates these reactions. These reactions become the cause of acid rain.

Increase in temperature of the surroundings:

For manufacturing of cement, kiln requires about 1700◦ C to 1900◦C. To achieve this temperature, fossil fuels are burnt that raise the temperature of the surroundings. In fertilizer industry, production of ammonia needs high temperature. Combining the nitrogen from air with the hydrogen from natural gas produces ammonia. It is a reversible as well as an exothermic reaction. For lifting the nitrogen atoms out of energy valley a high temperature reaction is needed. These procedures raise the temperature of the surrounding areas whose outcome is rain scarcity in the particular areas.

Global Warming:

Carbon dioxide (CO2), carbon mono oxide (CO), Sulphur dioxide (SO2) and oxides of nitrogen (NOx) all of these are greenhouse gases. Cement and fertilizer industry emit greenhouse gases in large amounts which increases the effect of global warming. Global warming changes the snow and rain patterns. Increase in droughts and melting of glaciers are also the impacts of global warming.

4. CONCLUSION

Remedies for Industrial Waste Water:

Aerobic Treatment of Waste Water:

Aerobic treatment is used for removing organic compounds (BOD or COD) and for oxidizing ammonia to nitrate. Aerobic treatment is a biological process. In this procedure, oxygen is used for breaking down organic matter and for removing other contaminants like nitrogen and phosphorus. In aerobic treatment, organic matter is transformed into carbon dioxide and new biomass. There is a continuous need of oxygen in aerobic process. That's why, from an air blower or compressor is mixed with waste water. Waste is turned into pieces. Recyclable elements are separated before this procedure. Aerobic bacteria consume the waste of this water in this way aerobic process is done.

Activated Sludge Process:

In the activated sludge process, the responsibility of removal of contaminants is on the activated sludge. It is the most commonly used biological waste water treatment technology. Many activated sludge configurations have been developed.

Ultra Filtration:

In waste water, ultra filtration devices are used for recycling and reusing water that contains almost no physical solids. Ultra filtration is done for removing macromolecules and particulates from raw water for making it fit for drinking purposes. Ultra filtration filters out bacteria, parasites and viruses. It also retains minerals in the water.

Disinfection Process of Industrial Waste Water:

Disinfection of treated waste water is done by various methods. Most commonly used methods are

- Chemical
- Physical
- Biological

Remedies for Industrial Contaminated Soil:

Biological Treatments:

There are two main technologies of biological treatments

- Bioremediation
- Phytoremediation

3.2.1.1. Bioremediation of Contaminated Soil:

Bioremediation is a process which is used for treatment of polluted soil, water and subsurface material. Environmental conditions are changed for exciting the growth of microorganisms and the targeted effluents are reduced. Usually, bioremediation is cheaper and long lasting than other remediation processes.

Usage of living microorganisms for cleaning up contaminated sites is called bioremediation. Microorganisms remove toxic from materials.

3.2.1.2 Phytoremediation Processes:

Phytoremediation is a bioremediation process which utilizes plants for the removal, transfer, stabilizing and destruction of the contaminants in ground water and soil.

In this process, green plants are used for removing, containing or reducing the toxic contaminants [19]. For this process, plants are specially chosen or genetically engineered. These plants directly consume effluents from the environment [20]. Numerous plants e.g. alpine pennycress hemp, mustard plants, sunflower and pigweed are proved effective at hyper accumulating effluents at contaminated sites.

Some other methods:

There are some other physical and chemical processes which can be used for removing soil contamination. Thermal desorption, soil washing, soil flushing, electro kinetic, soil vapor extraction, in situ and ex situ etc. but these methods are costly and less effective. Therefore, they are not commonly used. (Alva, *et al.*, 2006), Coal Combustion Byproducts and Environmental Issues,. 1st Ed. Springer Link.

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