CHAPTER - 7
SUMMARY AND CONCLUSION
A quick rise in population, rapid industrialization, increasing urbanization, growth of science, technology and advanced agricultural practices aimed at increasing the protection of human life, and it is the main feature of a modern society. In this process of development, however little thought was given to the effect of wastes, which such a society generates, in the environment. In slow degrees these waste have been polluting the environment and threatening the very existence of healthy life. The natural environment is clean, but due to multifarious activities of man, it get polluted resulting in what is called as environmental pollution. Pollution is an undesirable change in the physical, chemical or biological characteristics of our air, land and waters that may or will harmfully affect human life or that of desirable species, our industrial processes, living conditions and cultural assets; or deteriorate our raw material sources.

The present thesis entitled "Soil Pollution caused by cement industries, an agricultural and electroanalytical study" has been chapterised into six chapters. The first chapter deals with introduction. A pollutant discharged into the environment is subjected to abiotic and biotic agencies of transport, transfer and degradation. The cumulative result of action of these agencies is that the pollutant is degraded into simple constituents and ultimately eliminated from the environment. Degradation of some of the pollutants is a quick and efficient process while for others it may take a longer period, at times several years. Persistent pollutants such as toxic elements are usually scattered and diluted to such extent that their existence poses no danger to living organisms, but a long time exposure to them brought the lethal effects on living organisms, by altering the metabolic and physiological process at intra and inter cellular level.

Cement is one of the most used product during the process of civilisation since long time. It has got the status of only compound, to be used for several construction activities, used both for binding and strengthening of a structure. Portland cement is chemically defined as the finely ground mixture of calcium aluminates and silicates of varying
compositions. It hydrate when mixed with water to form a rigid solid structure having good compressive strength. More than 1.7 billion tons of cement is produced annually.

Chapter two deals with the review of cement industries. In India, presently 118 cement industries are working in different states, out of which 97 industries are working with dry process and 13 are working with wet process. Annual production of cement from these industry in 2001-2002 was 93606.53 thousand metric tonnes.

Presently there are 13 cement factories in Madhya Pradesh, producing 14010.31 thousand metric tonnes of cement per annum. Diamond cement Factory is situated in Damoh district of Madhya Pradesh and having two production units one at Narsingarh and another one at Imlai near Damoh district headquarters. The annual production capacity of these two units is 690 thousand metric tonnes of cement per year.

The cement factory affects the environment in several ways: The conversion of limestone to clinker involves the thermal decomposition of calcium carbonate into calcium oxide and carbon dioxide (calcination). The latter is released to the atmosphere in large quantities from the kiln during operation. Cement and nitrogen oxides in the atmosphere is very stable. It takes a very hot flame to disrupt it. Nitrogen oxides are therefore generally produced only by processes involving high temperature combustion. As the cement kiln runs very hot, the cement industry also produces higher amount of nitrogen oxides.

During the extraction and further processing of cement dust is various stages of the work due to process conditions. This dust is a mixture of Ca, K, Al, Si and Na which sets into hard mass when comes with the contact of water, during slow hydration of calcium aluminate and calcium silicate (CaO, SiO₂) hydrated colloidal gels are formed which crystalline out to form a thick in pervious surface, also in this process hydroxide of calcium and aluminium are produced to the surface interstices.
The major sources of a dust in a cement manufacturing plant are (i) Crushing and mixing of raw materials (ii) burning of the cement (iii) crushing of the cement (clinker and gypsum) and slaking of the lime.

Considerable amount of dust emitted from the cement factory ranges between 3 to 5 percent of the total cement production. The cement dust is composed of the small particulate matter. These particles depending upon their size may remain air borne for varying length of time, and then settled down on the earth surface affecting the surface in various ways.

The cement dust emitted from the kiln deposited on all direction and heavily affected ecosystem in one or other way. Experiments have been assessed to find out the effect of cement dust pollution on soil properties. Cement dust has shown to adversely affect the soils of ecological communities, it was observed that the effect of cement dust on mechanical and chemical properties of the soil reduced with the increase in distance from the source of pollution.

Chapter three deals with a focus on soil and its pollution caused by cement dust. Soil showed decrease in water holding capacity with decrease in distance. pH of the dust affected soil was also found to be higher near cement factory. But the electrical conductivity was found to be decreasing with the increase of distance. Calcium carbonate and organic carbon was found higher in the soils near the cement factories.

Nitrogen content of the soil was also showed a descending trend with increasing distance, while as phosphorus showed ascending trend with increasing distance, and potassium content was also higher near the cement plants.

As the dust contained heavy particulate matter, it slowly settle down to the ground, thus quantity of dust found to be higher in nearby area and decrease with the increase in distance. After settling down on the earth, it form a crust on the soil, and produces cumulative effect on the properties
and contents. Cement mainly contains CaCO$_3$ and raise the pH of soil and
due to damaging of porosity it influence water holding capacity and thus ion
concentration, which tens to lead make soil saline. As the crust form above
the soil and higher pH organic matter also get affected. Nitrogen
mineralisation process also decreases showed by the higher amount of
available nitrogen, calcium forms chelates with phosphorus, thus availability
of phosphorus declined. On the other hand higher ion concentration was
shown by higher potassium content. And these all conditions are not
favourable for the growth of plants and microbes, and tend to make soil
unfertile and low crop yield.

Chapter four deals with the effect of soil pollution on agriculture and
its eradication by use of fertilizers. By means of affecting on soil properties
and encrustations on plant parts, cement dust affects crop growth very badly.
The capacity of cement dust polluted soil to support the growth and yield of
crop have been measured by pot experiments with relation to distance from
cement plant. Wheat and gram crops were taken as test crop and
parameters of percentage germination, plant height, dry weight of 1 gm.
plant, no. of seeds per plant and yield per plant were taken to measure the
effect of distance and of fertilisers on soil. All these parameters were found
to be lowering with decrease in distance.

The habitat transformation is affected by formation of a cement crust
on the soil surface and by changes in porosity, water holding capacity, pH,
organic carbon and exchangeable Ca$^{++}$ and K$^+$ in the soil. These all
parameters have cumulative effect on the properties of the soil, which
ultimately affect the growth and reproduction pattern of a plant.

To recover the fertility of soil and its capacity to nourish the soil the
plants, amendment of external source of fertilizers is highly needed in
polluted soil, which helps to rejuvenate the soil for proper functioning.

Keeping above in mind further experiments were performed with
chemical and natural fertilizers. Crop of wheat showed maximum increment
in all six parameters in the polluted soil mixed with P fertilizer. In case of
Gram crop results were not found same as that of crop of wheat. In gram phosphorus fertilizer did not support very well when amended alone. But a combination of all three fertilizer (NPK) gave the best support for fertility of soil.

With a view, in light of, these results that the phosphorus fertilizer supported the polluted soil to grow both of above crops very well, further experiments were done with amendments of different quantity of phosphorus fertilizer in polluted soil. In wheat crop combination of N and P fertilizer suppressed all the parameters, and P fertilizer when amended singly supported the growth and yield upto a mark extent. But in case of P fertilizer supported the growth in a curved manner. It was a combination of N&P fertilizer, which supported the growth of gram crop very better.

Phosphate fertilizer is a form of soluble phosphorus, when phosphorus is applied to polluted soil, the granules of mono calcium phosphate absorb water from surrounding soil and formed a acidic solution \( (\text{H}_2\text{PO}_4)^- \). This solution reacts with soil mineral dissolving large amount of \( \text{Ca}^{++}, \text{Al}^{+++}, \text{Mg}^{++} \text{and Fe}^{++} \). Some of these are subsequently precipitated as new compounds with low solubilities. The mobility of phosphate is reducing resulting in its availability of plants. This conversion of water soluble phosphate after reacting with soil constituents and converting into insoluble phosphate is known as fixation thus only 15% to 20% absorption of phosphate take place.

Phosphate fertilizer makes polluted soil supporting plant growth much better than other fertilizer, because that cement dust deposited on the soil removed away phosphorus as soluble phosphate ion and become available for the plant growth by sorption.

It can be suggested that Phosphorus along with nitrogen fertilizer gives better growth to leguminous plant (like gram), because addition of phosphate fertilizer with nitrogen fertilizer increase the nodules proliferations over the roots, because they help in nutrition of bacteria responsible for nodules formation and it helps in fixation of nitrogen.
Chapter five deals with electro analytical study for detection of some toxic metals in cement dust polluted soil. Alongwith the carbon dioxide, nitrogen oxides, calcium carbonate and gypsum, the cement dust also contains dioxins and heavy metals like cadmium, chromium, zinc, lead, arsenic, antimony, barium, beryllium, silver, mercury, thallium and selenium.

Toxic metals when once made available to the environment, metals are not removed rapidly, nor they readily detoxified by metabolic activity. These metals enters into the human food chain through air, water and food. The toxicity of the metal ions to mammalian systems is due to chemical reactivity of the ions with cellular structural proteins, enzymes and membrane systems. They affects the active sites of enzymes, inhibiting essential enzyme function and interfering with cell metabolism.

An Electroanalytical approach was made to analyse the presence of cadmium and lead in cement dust polluted soil and it was found that both of the toxic metals were found in increasing levels with decrease in distance. After a increased distance the effect of toxic metals is nullified.

Chapter six is a review on effect of cement dust pollution on human health. Flying cement dust before when settling down on earth, float for a long time in the air and due to continuous generation, it concentrate in the atmosphere. During its journey from chimney to earth it passes through the neighbouring atmosphere and suspended particulates matters present in it enters into the body of a man.

Freshly generated cement dust may be corrosive to damp moist skin, inhalation of this dust may cause sore throat, coughing, choking and dyspoea.

A review was also made to understand the effect of these toxic metals on human health present in cement dust. And following disorders were received to be frequent in persons either residing near cement factories and or occupational.

Toxic metals present in cement dust enters in the body by way of inhalation, ingestion, skin and eye contact.
Literature suggested that lung function disease, respiratory tract injury, decrease in lung capacity, chronic respiratory symptoms, allergic contact dermatitis are the most common effects of cement dust on human health.

The worst health hazards of cement dust are laryngeal and sinonasal cancer, malignant mesotheliomas are the worst effects of cement dust on human health.

As such cement dust is a highly dangerous pollutant affect both plant and animal communities. When it float in air cause respiratory, skin and eye diseases in humans and by blocking the sun rays, affect the photosynthesis in plants. And when it settle down on the earth formed a impervious crust and alter the soil properties, and by way of affecting soil properties, it causes decrease in plant growth and yield. Toxic metals, present in cement dust polluted soil, accumulated by plants and ultimately reaches into human body. Phosphorus fertilizers can be helpful in lowering the effect of cement dust on soil.

On the basis of above discussion following can be concluded, for conservation of the soil, human health and environment.

(1) Cement factories must be careful in precipitating the cement kiln dust, proper precautions are to be adopted for minimising the environmental losses.

(2) Soils are to be neutralised and fertilized properly to keep it in fertile conditions.

(3) A further study is required to find out the methods for eradication of toxic metals present in cement dust and dust polluted soil.

(4) Further study is required to find out the accumulation of toxic metals by different crops grown in cement dust polluted soil, and to assess the effect of their consumption on human health.
RESEARCH PAPER/PUBLICATIONS

1. Soil pollution caused by cement dust and its effect on human health with Cadmium as a pollutant present in it: A polarographic study.
   V.K. Chitale, Kiran Dubey, Mukul Sinha, R. Jain and S.K. Pandit
   National seminar on the interdisciplinary area of science and technology: present and future, held at Department of Zoology, Dr. H.S. Gour Univ. Sagar, March 21-22, 1998, p. 8.

2. Effect of fertilizers on the growth of Triticum vulgare in the study area of cement dust polluted soil.
   V.K. Chitale and Kiran Dubey

3. Pollution of soil by cement Industries: A chemical approach.
   V.K. Chitale, R. Jain, Kiran Dubey, M.P. Tripathi and Mukul Sinha

4. Soil pollution caused by cement dust and its effect on human health with lead as pollutant present in it: A polarographic study.
   V.K. Chitale, Kiran Dubey, Rashmi Jain and Mukul Sinha
   National research seminar on synthesis of new chemical compounds and their impact on agriculture, pharmaceutical, food, cosmetics and allied industries, held at Govt. P.G. College, Satna, January 24-25, 1999, p. 25.

5. Influence of N&P fertilizer on the growth of Gram Cicer arietium in polluted soil caused by cement dust.
   V.K. Chitale and Kiran Dubey
   National research seminar on population growth and environmental degradation, held at P.G. College, Damoh, January 8-9, 2000, p. 10.
INTERDISCIPLINARY APPROACH

IN

SCIENCE AND TECHNOLOGY

DWARKA PRASAD GUPTA
SUBODH KUMAR JAIN
POLLUTION CAUSED BY CEMENT DUST AND ITS EFFECT ON HUMAN HEALTH WITH CADMIUM AS A POLLUTANT PRESENT IN IT:
A POLAROGRAPHIC STUDY

V. K. Chitale, Kiran Dubey, Rashmi Jain,
Mukul Sinha and S.K. Pandit
Department of Chemistry
Govt. P.G. College, Damoh (M.P.)

ABSTRACT: The progress of civilization since the independence has been phenomenal, but rapid industrialisation has also brought the danger of pollution. Today almost every thing around us has been polluted like water, air and soil. Some of the dangers for soil pollution are due to effluents given off by various industries like cement, metallurgical operations etc. Soil is one of the most ecological factor, which is transformed from the surface rocks and plants depend on it for their nutrition, water supply and mineral supply (R). Thus soil is the most valuable heritage. Portland Cement is one of the most important building materials at the present time. It also causes pollution in air as well as in water and soil where cement industries are present. Chemically cement is a mixture of Calcium alumino silicate containing small amount of Cd, Pb, Fe, Ti and silica. It covers the surface of the earth, thus polluting soil, plant leaves, water in the surrounding area. The present paper is an attempt to analyse Cd content in the polluted soil in Cement industry area by polarographic technique. This technique is the most predominant technique and microgram analysis can be made with it very easily and accurately.

MATERIAL AND METHODS

(A) COLLECTION OF SOIL SAMPLES (R)

Soil samples were collected from the clifferen distances of cement industry area. The importance of soil analysis is to know the nature of soil, because the production of crop in any region depends on the properties of the soil.
soil. Soil samples collected as per procedure given below:
i. Clean the polythene bags used for collecting and mixing soil samples.
ii. With an angle a boring about plough deep (6 inches) made and pulled it up with the soil. Each soil sample marked with the help of paper tags indicating full particulars.
iii. Collected sample from the area spread over the polythene sheet for drying when it is sufficiently dry to pass through between the fingers, removed foreign matter like loose roots and small stone etc.

The dried soil samples after grinding in wooden pestle and mortar were mixed thoroughly and passed through 2mm diameter sized sieve and then are ready to use for the analysis of physicochemical as well as mechanical properties of the soil samples.

(B) METHOD

10 gm of soil samples obtained from different polluted area is heated strongly with concentrated HNO₃ and filtered out, it was then put in a standard flask to definite volume. 10 ml of this solution was mixed up with 10 ml KNO₃ to be used as supporting Electrolyte and 0.01% gelatin solution was used as maxima suppressor, this was used as a test solution.

Stock solution of Cd(NO₃)₂, KNO₃ and gelatin 0.01% were prepared in doubly distilled water.

EXPERIMENTAL

The Chemical used during the experimental were of BDH /Analar grade. Cd(II) Nitrate Solution was prepared by dissolving calculated weight of CdCO₃ in HNO₃. It was subsequently evaporated to dryness and finally residue was extracted in conductivity water and standardised (R) KNO₃(2M) and gelation solutions were prepared in doubly distilled water. The pH of the test solution was adjusted by dilute HCl and NaOH solutions.

An automatic pen recording polarograph (CIC Baroda, India) was used to record the polarograms. The character stics of the dropping mercury electrode in 1.0 M KNO₃, Open circuit were m=2.37 Mg/s , t=3.0 s at 35 cm of effective height of mercury column m 2/3 t 1/6 = 2.136 mg 2/3 st-1/2).
Pure nitrogen gas was passed through the test solution to deaerate it. An Elico digital pH meter was used to measure the pH of the test solutions. All the measurements were made at room temperature 25+ 0.1°C.

OBSERVATIONS

A Series of polarograms were recorded with known value of Cd(II) solution and unknown soil samples and in each of \( i_d \) (Diffusion current) was plotted to know the concentration of unknown solution present in the soils samples, the observation are recorded in TABLE No.1. It is interesting to know that a distance from the Cement factory increases concentration of Cd (II) decreases in the soil and pollution decreases.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Distance</th>
<th>( i_d ) Value</th>
<th>Amount of Cd in mg.</th>
<th>(-E_{1/2} ) V Vs SCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>0.5 Km.</td>
<td>108</td>
<td>0.004</td>
<td>0.46</td>
</tr>
<tr>
<td>2.</td>
<td>1.0 Km.</td>
<td>90</td>
<td>0.0038</td>
<td>0.46</td>
</tr>
<tr>
<td>3.</td>
<td>1.5 Km.</td>
<td>68</td>
<td>0.003</td>
<td>0.46</td>
</tr>
<tr>
<td>4.</td>
<td>2.0 Km.</td>
<td>46</td>
<td>0.0028</td>
<td>0.46</td>
</tr>
<tr>
<td>5.</td>
<td>3.0 Km.</td>
<td>24</td>
<td>0.0022</td>
<td>0.46</td>
</tr>
</tbody>
</table>

RESULTS AND DISCUSSION

Cd(II) gives a well defined two electron reduction wave in 1.0 M KNO_3 and 0.01% gelation with \( E_{1/2} = -0.46 \) V Vs SCE. The reduction of Cd(II) is diffusion controlled and reversible in nature, which is evident from the straight line plot of wave height against the effective height of mercury column and passing through the origin. \( i_d \) diffusion current is proportional to the concentration and this helps in determining the concentration of unknown solution. Half wave potential is a characteristic property of a metal ion and therefore used in the qualitative and quantitative determination of metal ions.
with accuracy upto nanogram level. In the present study it was known that Cd(II) concentration decreases as the distance from the industry increases and after 5 Km. its effect is nullified.

EFFECT OF Cd (II) ON HUMAN AND DISEASES CAUSED BY POLLUTION

It is recognised as on environment pollution.
Brief inhalation of Cd(II) can lead to serve pulmonary changes. Cd(II) deposits in Kidneys causes the formation of Kidney stones.
It causes a foetal disease called itai itai. It causes rickets and rupture of bone structure of the body especially in females.
Hospital report of Damoh (M.P.) showed that 2% patients suffering from T.B. and 2.5% from Diarrhoea and Dysentery, by the Cement Pollution Skin deseases also affected the persons.

ACKNOWLEDGEMENT

Authors are thankful to the Director of C.I.C. Baroda, and Principal Prof. K. S. Kandhari for encouragement and Lab facilities.

REFERENCE

ICCE-2001
ABSTRACTS OF PAPERS
presented in the Congress
16th to 18th December, 2001

INTERNATIONAL CONGRESS OF
CHEMISTRY AND ENVIRONMENT
(under the auspices of Research Journal of Chemistry and Environment)
A/80, Scheme 54, Vijay Nagar, A.B. Road, INDORE 452010 (M.P.) INDIA

Venue:
Govt. Nutan Girls P.G. College
Kila Maidan, INDORE 452 006 (M.P.), INDIA
Effect of Fertilizers on the Growth of Triticum Vulgare in the Study Area of Cement Dust Polluted Soil

V.K. Chitale and Kiran Dubey*
Department of Chemistry, Govt. P.G. College, Damoh (M.P.), INDIA.

Abstract:
Soil plays an important role as it produces food for human beings and animals, but due to human activities, Soil is a receptor of many pollutants like pesticides, cement dust and power plant smokes. It has been observed that constant fall of cement dust in Industry areas cause soil pollution. It is well known that Calcium silicate and calcium aluminate present in cement dust which form colloidal gels, which after crystallisation and solidification develop in to a hardcrust causing low yield of crops.

In the present study samples of soils from nearby villages of cement industries are collected and seeds of triticum vulgare were grown using various fertilizers in the winter season. It has been observed that super phosphate of lime gave 10 times yield as compared to other fertilizers of organic and inorganic origin. This can be explained well as super phosphate removes calcium content from the polluted soil and thus causing soil available to the developing plants for their proper growth.

****
Pollution of Soil By Cement Industries - A Chemical Approach

V.K. Chitale*, Rashmi Jain, Kiran Dubey, M.P. Tripathi and Mukul Sinha
Department of Chemistry, Govt. P.G. College, Damoh (M.P.), INDIA.

Abstract:

Soil is the receptor of large quantities of waste products obtained from domestic, human, animal and industrial decay. The soil of the earth is the store house of nature and mother of all plants, animals and human beings. It has been observed that constant fall of cement dust on soil causes pollution. Chemical analysis of soil in the industry area of cement in Damoh District has been studied and it was observed that as the distance from factory increases, the effect of soil pollution decreases considerably for pH, nitrogen content, phosphorus content, potassium content and soluble salts. The fertility of soil is mainly because of N, P, K contents, which is hardened by Ca aluminate and calcium silicates deposits on the soil surface and non availability of these prime elements to the agriculture. The loss of agriculture is a great hazard to the man kind for generations together.
SOIL POLLUTION CAUSED BY CEMENT DUST AND ITS EFFECT ON HUMAN HEALTH WITH LEAD AS A POLLUTANT PRESENT IN IT - A POLAROGRAPHIC STUDY

V.K. CHITALE, KIRAN DUBEY, RASHMI JAIN and MUKUL SINHA
DEPARTMENT OF CHEMISTRY, GOVT. P.G. COLLEGE, DAMOH (MP)

ABSTRACT:

The quality of life has been a point of discussion for last some decades as pure water, good food and healthy atmosphere seems to be the burning problem before the society. On one hand industries are useful in furnishing proper changes of employment but on the other hand Pollution caused by them has become of immense importance for the human health.

Cement is mainly composed of lime, Alluminium Oxide and Iron Oxide along with traces of Pb(Lead) as one of the important constituents causing Pollution in Cement Industry areas. It has been reported in literature that Pb(II) causes cancerous growth in lungs by its prolonged inhalation through respiration.

The trace of Pb(II) can be detected successfully by polarographic method it has been mentioned in literature that Pb(II) gives a well defined two electron reduction wave in KNO3 (0.5M) used as supporting electrolyte and gelatin as Maxima Suppressor with E1/2 0.62 V vs SCE as reference electrode. The wave is diffusion controlled as iξ is directly proportional to the concentration. To know the pollution caused by cement in the area some dust is dissolved in water and soluble Pb(II) part is extracted with HCl. This analyte is mixed with KNO3 and gelatin and polarogram is recorded on CIC Baroda India Polarograph. The concentration of this Unknown sample is detected by graph plot method. Polarography is very sensitive technique and its detection limit is up to nanogram level which can be recorded successfully.

National research seminar on synthesis of new chemical compounds and their impact on agriculture, pharmaceutical, food, cosmetics and allied industries, held at Govt. P.G. College, Satna, January 24-25, 1999, p. 25.