CHAPTER-5
SUMMARY AND CONCLUSION
Water contamination is a global problem that can result in illness and death. Consumption of contaminated drinking water is particularly problematic in third world countries where inadequate purification processes, coupled with rapidly increasing population growth and industrialization pose serious health risks. The production of wastewater from human activities is unavoidable. A significant part of this waste will end up as wastewater. The quantity and quality of wastewater is determined by many factors. Not all humans or industries produce the same amount of waste. Generally waste water constituents are metals such as Pb, Cd, Cr, Cu, Ni, Zn and Hg, organic materials such as detergents, pesticides, fat, oil, grease, coloring dyes, some solvents, gases like H₂S, phenols and cyanides which imparts odour and taste of industrial and sewage wastewater. The inorganic constituents that creates waste water by adding acids, bases etc. Other waste water constituents are micro-organisms, bio-degradable organic materials badly affects the flora and fauna of water ecosystem.

Heavy metal pollution has become one of the most serious problems today, and the use of microbial and plant biomass for the detoxification of industrial effluents for environmental protection and recovery of valuable metals offers a potential alternative to existing treatment technologies. Heavy metal pollution can arise from many sources but most commonly arises from the purification of metals, e.g., the smelting of copper and the preparation of nuclear fuels. Electroplating is the primary source of chromium and cadmium. Through precipitation of their compounds or by ion exchange into soils and mud, heavy metal pollutants can localize and lay dormant. Unlike organic pollutants, heavy metals do not decay and thus pose a different kind of challenge for remediation. Currently, plants or microorganisms are tentatively used to remove some heavy metals such as mercury. Plants which exhibit hyper accumulation can be used to remove heavy metals from soils by concentrating them in their bio matter. Some treatment of mining tailings has occurred where the vegetation is then incinerated to recover the heavy metals.

Motivations for controlling heavy metal concentrations in gas streams are diverse. Some of them are dangerous to health or to the environment (e.g. Hg, Cd, As, Pb, Cr), some may cause corrosion (e.g. Zn, Pb), some are harmful in other ways (e.g. arsenic may pollute catalysts). Within the European community, the 13 elements of highest concern
are As, Cd, Co, Cr, Cu, Hg, Mn, Ni, Pb, Sn, and Ti, the emissions of which are regulated in waste incinerators. Some of these elements are actually necessary for humans in minute amounts (Co, Cu, Cr, Ni) while others are carcinogenic or toxic, affecting, among others, the central nervous system (Hg, Pb, As), the kidneys or liver (Hg, Pb, Cd, Cu) or skin, bones, or teeth (Ni, Cd, Cu, Cr). Due to the corrosive nature of Cr (VI) it creates skin and mucous membrane ulceration generally observed in chromplating workers. Consumption of large amount of Cr (VI) causes stomach, ulcers, convulsions, kidney and liver damage and even death. The World Health Organization (WHO) has determined that Cr (VI) is a carcinogenic. Cr (VI) beside being inorganic, causes serious threat to aquatic biological environment. However, in trace amount Cr(III) is an essential element in mammalian metabolism and together with insulin it is responsible for the clearance of glucose from blood stream. In view of potential toxicity of Cr (VI) it should be removed from waste water before being discharged. The 17-20% of industrial freshwater pollution is caused by textile dyeing and treatment. Estimation state that 10-15% of total dyestuff equivalent to 280,000 tonnes of dyestuff used during the manufacturing of textile products is released into the environment worldwide annually. Direct discharge of these effluents causes formation of toxic aromatic amines under anaerobic conditions in receiving media. Textile wastewater is diverse in chemical composition and is considered as most polluted among all industrial sectors. The aquatic environment is the ultimate destination for almost all industrial wastes and water quality gets seriously impacted by these waste products.

Phenols of anthropogenic origin exist in the environment due to the activity of the chemical, petrol, tinctoral or pharmaceutical industries. The compounds penetrate ecosystems as the result of drainage off the municipal or industrial sewage to surface water. Toxic influence of organic compounds depends on many factors. Penetration of phenol to organisms is related with diffusion of the compound across a cell’s membrane. The factor that strongly affects diffusion is hydrophobicity of the individual compound. The increase of hydrophobicity affects the more effective penetration of a cell’s membrane by phenol and thus enhances the toxicity of xenobiotics. The removal of metal ions and organic moieties from industrial waste water is attracting the attention of
researcher not only for pollution control but also to enable to treat the water. Conventional waste water treatment process have their own limitations and drawbacks.

Ion exchangers find tremendous application in industries because of greater reactivity and higher exchange properties. Due to the non biodegradable nature of heavy metal’s concentration in the environment increases tremendously. Industrial effluent coming out from chromplating, aluminium anodizing, leather mining, ink and pigment unit, lithography, oceanography etc. contains appreciable amount of chromium. In the present research, the adsorption study were performed by employing magnetic nanoadsoebent for the removal of different toxic metals and the removal was found to be higher for Pb, Zn, Cd, Ni, Cu and Cr among the 11 metals studied As, Se, Zn, Cd, Ni, Co, Pb, Mn, Hg, Cr and Cu. Different from other organic pollutants, hazardous heavy metals are indestructible, as they cannot be chemically or biologically degraded. Even worse, some heavy metals can concentrate along the food chain and eventually accumulate in human body because we are at the top of the food chain. Therefore increasing attention has been paid in recent years to the remediation of polluted water bodies like rivers, lakes, ponds along with industrial effluents and soils, among which the use of magnetic nano materials to remove hazardous organic and metallic moieties is particularly emphasized. Industrialization of the textile industry and use of a large variety of chemical treatment and dyes has resulted in a public health threat created by pollution.

For this study industrial wastewater sample was from collected Vapi GIDC (GUJ) India. The detection and identification of metals was carried out by FTIR & ICP-AES techniques at Department of Earth Science, IIT, Mumbai. The physicochemical analysis was carried out to see the pollution status of the sample. This efforts made for removal of organic and metallic moieties by using magnetic nanoadsorbents during development of methods we have been conducting batch experiments for the optimization of process parameters like initial contact time, pH, initial concentration, amount of magnetic nanoadsorbents. The synthesized magnetic materials was characterized by FTIR at G.T. patil College, Nandurbar, SEM-EDS, XRD at North Maharashtra University, Jalgaon, Sophisticated Instrument Center for Research and Technology, Vallabhbh Vidyanagar, (Guj). and VSM at IIT Kharagpur at Madras techniques. This treatment
procedure may solve the problem associated with conventional methods. The outcome of the work beneficial for designing the wastewater treatment plant.

The problem of water pollution is concerned, therefore this efforts of investigation of removal of metals and organics is an important for the treatment wastewater. It is important that all the toxic moieties should be removed completely from wastewater then treated industries effluents are allowed to drain. For the treatment of industrial effluents, it is proposed that synthesized magnetic nanoadsorbents which are capable to remove organic and metallic moieties by suitable unit treatment processes and techniques. The traditional adsorbent were used for removal of organic and metallic moieties but shows poor recovery of the target toxic metal ions from a large volume of metal solution, due to low binding capacity diffusion limitation and the lack of active surface sites. Hence it is need to synthesize an effective magnetic nanoadsorbents with a large adsorptive active surface area, low diffusion resistance, high adsorption capacity and fast separation for large volume of metals solution.

The results thus obtained during the course of present investigation are being described and discussed under the following sections:


Section-II : Development of Magnetic Nanoadsorbents Methods for the Removal of Cadmium Metal and Characterized by XRD, SEM, EDS, and FTIR Techniques.

Section-III : Development of New Photocatalytic method for the Treatment of Industrial Waste Containing Lead and Characterized by XRD, SEM, EDS and FTIR Techniques.

Section-IV : Equilibrium and Thermodynamic Studies of Metals Removal.

Section-V : Detection of Metals from the Wastewater (Industrial or Sewage) by ICP AES.

Section -VI : Study the Application of Prepared Novel Magnetic Nanoadsorbent.

Section-VII : Statistics of the Collected Physico-Chemical Results.
Section-I


Chemicals are part of our daily life. All living and inanimate matter is made up of chemicals and virtually every manufactured product involves the use of chemicals. Many chemicals can, when properly used, significantly contribute to the improvement of our quality of life, health and well-being. But other chemicals are highly hazardous and can negatively affect our health and environment when improperly managed. WHO compiled a list of the 10 major chemicals of concern, which includes many heavy metals Air pollution, As, Asbestos, Benzene, Cd, Dioxin and dioxin-like substances, Inadequate or excess fluoride, Pb, Hg, Ni, Cu.

Heavy metal pollution can arise from many sources, but most commonly arises from the purification of metals, e.g., the smelting of copper and the preparation of nuclear fuels. Electroplating is the primary source of chromium and cadmium. Through precipitation of their compounds or by ion exchange into soils and mud, heavy metal pollutants can localize and lay dormant. Unlike organic pollutants, heavy metals do not decay and thus pose a different kind of challenge for remediation, from the above point of view it is need to develop the new treatment methods and nanoadsorbents for the removal of toxic metals form the industrial wastewater to control the water pollution.

The detail methods was described and discussed in the two subsections.

A) Removal of Cr$^{6+}$ by Magnetic Nanoadsorbents from the Industrial or Sewage Wastewater.

B) Removal of Ni (II) and Cu (II) by using different Semiconducting Materials.

A) Removal of Cr$^{6+}$ by Magnetic Nanoadsorbents from the Industrial or Sewage Wastewater.

The heavy metals pose a serious water pollution problem especially contamination of portable groundwater with heavy which creates health hazards also its concentration is high in industrial and sewage wastewater. The main focus of this study to remove heavy metal chromium from contaminated water by using synthesized iron oxide nanoadsorbent (ION). The batch adsorption study was conducted for the removal of chromium along with different parametric studies such Initial concentration of
chromium metals, adsorbent dose, pH, contact time and temperature. The employed ION gives positive results, the absorption of chromium is very rapid and most of fixation occurs at first 30 minutes. The adsorbent was characterized by before and after treatment of Chromium contaminated water, such as SEM-EDS, FTIR,. The adsorption kinetics obey second order kinetic. The result suggests that ION can be beneficial in chromium removal from the contaminated water.

In this study a magnetic nanoadsorbent were synthesized by co-precipitation method is effective and eco-friendly and no sophisticated chemical and instruments were required. The magnetic nanoadsorbent prepar were employed for the adsorptive removal of heavy metals from industrial or sewage wastes. The adsorptive metals study shows positive results and obeys first order kinetics and adsorption study fit for the Langmuir and Freundlich model. Also other parametric study such as initial concentration, adsorbent dose, contact time, pH etc. shows effective adsorption. The present study shows that, Magnetic adsorbent can be used as an adsorbent for the removal of chromium from aqueous solution. The amount of chromium ion uptake (mg/g) found to increase with increasing contact time and the initial dye concentration, decrease with increasing adsorbent dosage. The rate of adsorption was found to confirm pseudo second order kinetics with a good correlation. Equilibrium data fitted very well in the Langmuir isotherm equation confirming the mono layer adsorption capacity of chromium ion on to magnetic nanoadsorbent with mono layer adsorption. The dimensionless separation factor (RL) called as equilibrium parameter showed that magnetic nanoadsorbent could be used for removal of chromium ion from aqueous solution.

The detail results of Chromium removal were described and discussed in section-I of Chapter-3.

B) Removal of Ni (II) and Cu (II) by using different Semiconducting materials.

In the present investigation the hazardous Ni (II) and Cu (II) metal removal studied with batch and kinetics by photocatalysis technique. The effect of various parameters like pH, agitation time, dose of catalyst, adsorption in dark and initial metal ion concentration have been studied.

In this study, photocatalytic removal processes have been employed for the removal of Nickel and Copper at different pH. Themaximum removal of Ni (II) and Cu
(II) was observed at pH 4. The treatment tests were also accomplished with and without UV irradiation in both experiments.

Removal of Ni (II) and Cu (II) from wastewater are possible by using semiconductor photocatalysts. It was observed that there is an increase in the rate of reaction as the intensity of incident light was increased. The order to effectiveness of photocatalysts used in the present investigation is TiO$_2$ > ZnO > CdS. Out of the three photocatalysts as TiO$_2$, ZnO and CdS. The TiO$_2$ is the best photocatalyst which remove more than 75% Cu (II) and Ni (II) metal. The reported data is useful for the designing as economically cheap treatment for removal of Ni (II) and Cu (II) from the chemical and allied process industry wastewater.

The detail results of Nickel and Copper removal were described and discussed in section-I of Chapter-3.
Section-II

Development of Magnetic Nanoadsorbents Methods for the Removal of Cadmium Metal and Characterized by XRD, SEM, EDS, and FTIR Techniques.

The environment and all the life forms on earth face a very serious threat from the heavy metal pollution due to rapid industrialization and the growth in the world population. At least 20 metals are classified as toxic and half of these are emitted into the environment in quantities that pose risks to human health. Agricultural development, urbanization and industrialization are the major causes for all changes in the quality of water. In order to meet the rising water needs, evaluation of water quality is important for allocation to various uses. Only during the last three decades of the twentieth century, the concern for water quality has been exceedingly felt so that, water quality has now acquired as much importance as water quantity. According to WHO, about 80% of all the diseases in human beings are caused by contaminated water. Once the groundwater is polluted, its quality cannot be renovated by stopping the pollutants from the source. It is therefore vital to regularly monitor the quality of groundwater. Groundwater pollution by heavy metals has been given much attention due to their low biodegradability and toxic effects.

Many toxic heavy metals are being discharged into the environment as industrial wastes, causing serious soil and water pollution. Heavy metals such as zinc (Zn), lead (Pb), cadmium (Cd), nickel (Ni) and copper (Cu) are priority toxic pollutants in industrial wastewater, which become common groundwater contaminants and they tend to accumulate in organisms, causing numerous diseases and disorders. The complexity of effluents makes the process of heavy metals removal more difficult due to the presence of organic legends, phosphate, cyanide and humic matter that can be added to complexity of removal, as well as strict limitations that have been imposed to wastewater discharge everywhere on aquatic recipients.

This section mainly focuses on the synthesis and characterization of Magnetic nanoadsorbents used for removal of cadmium metal from aqueous solution.

The detail methods was described and discussed in one subsection.

The effective removal of heavy metals from industrial wastewater is the most important issues for many industrialized countries and it is big challenge for human being. This research focuses on understanding adsorption process and developing a cost effective technology for treatment of heavy metals-contaminated industrial wastewater. In this investigation the $Fe_2O_3$ magnetic nano adsorbents are effective and posse’s high adsorption capacity and efficient removal rate.

In this research article iron oxide nano adsorbents have been employed for the removal of Cd(II) ions from aqueous solutions by batch adsorption technique. The amount of Cd(II) ions adsorbed increases as temperature increased. The optimal pH values for Cd(II) ions removal was in between 5.5 to 6.5 different other parameters are also studied such as initial concentration of metals, catalyst dose, contact time etc. The kinetic study also have been investigated for this research article and it is observed that Cd(II) ions removed by $Fe_2O_3$ magnetic nano adsorbent obey pseudo first order and pseudo second order kinetics model effectively.

Cadmium(II) is amongst the most toxic ions hazardous to living organism and its permissible limit in drinking water is 0.005 $mg/L$. Removal of cadmium from aqueous solutions can be accomplished by several techniques which include cementation, chemical precipitation, ion exchange, solvent extraction, membrane separation and adsorption. Adsorption is one of the most studied techniques.

The main experimental parameters which are studied to evaluate the adsorption behavior are time, pH, temperature, concentration of adsorbate and adsorbent, competing ions etc. The Characterization data like SEM and FTIR of Synthesized Fe$_2$O$_3$ gives good results. The time data are generally fitted to pseudo-first order and pseudo-second order kinetics. This study is applied for the treatment of electroplating and metal industry wastewater. The detail results of Cadmium removal were described and discussed in section-II of Chapter-3.
Section-III
Development of New Photocatalytic method for the Treatment of Industrial Waste Containing Lead and Characterized by XRD, SEM, EDS and FTIR Techniques.

The presence of toxic metal ions in wastewater remains a serious environmental concern. Therefore, it is necessary to develop various efficient technologies for their removal. A number of techniques have been used to remove the metal ions from wastewater effluents. The toxic heavy metal contaminants in wastewater due to discharge of metal containing effluents into water bodies is one of the most environmental issues of this century. Heavy metals are discharged in small quantities into the environment through numerous industrial activities. The heavy metal pollution represents a significant environmental problem arising from its toxic effects and accumulation throughout the food chain. Heavy metals such as chromium, nickel, lead, copper, etc., in wastewater are hazardous to the environment and health. Water pollution is of widespread national concern. Industrial activities generate a large number and variety of waste products.

The nature of industrial waste depends upon the industrial processes in which they originate. The problem of adequately handling industrial waste waters is more complex and much more difficult because industrial waste water vary in nature from relatively clean rinse waters to waste liquors than are heavily laden with organic or mineral matter or with corrosive, poisonous, inflammable or explosive substances. Pharmaceutical manufacturers, industries generate process wastewater containing a variety of conventional parameters (e.g. BOD, TSS, and pH) and other chemical constituents.

<table>
<thead>
<tr>
<th>Constituent Name</th>
<th>Quantity Discharged (Ibs/yr)</th>
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<tbody>
<tr>
<td>Methanol</td>
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<tr>
<td>Ethanol</td>
<td>6,802,384</td>
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<tr>
<td>Acetone</td>
<td>4,573,766</td>
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<tr>
<td>Isopropanol</td>
<td>4,565,370</td>
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<tr>
<td>Acetic acid</td>
<td>4,328,691</td>
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<tr>
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<td>3,590,640</td>
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<tr>
<td>Formic acid</td>
<td>2,136,059</td>
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<tr>
<td>Ammonium hydroxide</td>
<td>1,365,741</td>
</tr>
<tr>
<td>N,N-Dimethylacetamide</td>
<td>1,046,333</td>
</tr>
<tr>
<td>Toluene</td>
<td>7,83,364</td>
</tr>
</tbody>
</table>
This section synthesis and characterization of magnetic nanoadsorbents and their application lead removal from industrial effluents.

The detail methods was described and discussed in one subsection.


Magnetic nanoadsorbent is cost effective and easily synthesized in laboratory by chemical Co-precipitation method that provides not only high adsorption capacity but also rapid adsorption rate. The magnetic nanoadsorbents were synthesized by Ferric and Ferrous ion precursor solution in the presence of ammonium hydroxide. In present investigation magnetic nanoadorbent have been employed for the removal of Pb(II) from aqueous solution by batch adsorption technique along with photocatalysis. The different parametric study also carried out such as initial concentration of Pb(II), adsorbent dose, contact time, Solution pH. The Pb (II) was fast adsorption and equilibrium was achieved within 45 minutes. The amount Pb (II) adsorbed increases as increase in temperature. The optimal pH for Pb(II) was around 5.4. The employed adsorbents were characterized by SEM, X-ray diffraction (XRD), Vibrating spinning magnetometer (VSM) and FTIR. The Kinetic of adsorption study examine for pseudo first order model and pseudo second order models. This Photocatalytic adsorption study obeys Pseudo second order kinetic.

The present investigation of photocatalytic experimental research examine Kinetic of adsorption for pseudo first order model and pseudo second order models, adsorption study obey Pseudo second order kinetic. The parametric study shows removal of Pb(II) ions is clearly pH dependent with the highest adsorption and optimum pH at 5.4. The magnetic nanoadsorbent showed promising characteristics which can be used for the removal of heavy metals from industrial and sewage wastewater.

This method is particularly applicable for treatment of low-volume industrial streams, where disposal of relatively large quantities of sludge generated, is still an economically competitive solution when compared to other treatment options; in particular hauling for off-site disposal of the entire wastewater stream. In such small-scale applications, development and implementation of other treatment alternatives, generating potentially lower amounts of residuals, is frequently not justified due to cost. Treatment with magnetic nanoadsorbent offers a robust option, capable of removing heavy metals to ppb levels of complex matrix with metals present in various forms such as dissolved, colloidal, emulsified and particulate.
The magnetic nanoadsorbent with size of 45.8 nm were synthesized using a chemical co-precipitation method. This nanoadsorbent were successfully examine for the removal of Pb(II) metals from synthetic aqueous solutions.

The detail results of Lead removal were described and discussed in section-III of Chapter-3.

Section- IV
Equilibrium and Thermodynamic Studies of Metals Removal.

The increase of industrial activities has accentuated environmental pollution problems causing the deterioration of several ecosystems with the accumulation of many pollutants, such as toxic metals. Heavy metals are discharged from various industries such as storage batteries, textile, pigment, fertilizer, plastic, ceramic and glass manufacturing, mining, electroplating, and metallurgical processes. Heavy metals are persistent environmental contaminants since they cannot be degraded or destroyed. Heavy metal pollution represents an important problem due to its toxic effect and accumulation throughout the food chain leading to serious ecological and health problems.

Many industries such as metal-processing, paint, plastics alloy and the ammunition industries and so on, generating large quantities of wastewater containing various types and concentration of heavy metals. Although many heavy metals are necessary in small amounts for the normal development of the biological cycles, most of them become toxic at high concentrations. The heavy metal pollution is of greatest concern among the kinds of environmental pollution because of heavy metals’ high toxicity and mobility. It is well documented that lead is one of contaminants of industrial wastewaters and its pollution exists in the wastewater of many industries. Unlike most organic pollutants, heavy metals do not undergo biological degradation and tend to accumulate in the organisms, thereby eventually entering the food chains. All the chemicals compounds containing lead are considered as cumulative poisons. Removal and recovery of heavy metals are very important with respect to environmental and economical considerations. In this section equilibrium and thermodynamic study of heavy metals removal by magnetic nanoadsorbents from wastewater have been investigated.
The detail methods was described and discussed in one subsection.


An efficient and new magnetic nanoadsorbent photo catalyst was fabricated by Co-precipitation technique. This research focuses on understanding metal removal process and developing a cost effective technology for treatment of heavy metals-contaminated industrial wastewater. In this investigation magnetic nanoadsorbent have been employed for the removal of Zn(II) ions from aqueous solutions by a batch-adsorption technique. The adsorption equilibrium data fitted very well to Langmuir and Freundlich adsorption isotherm models. The thermodynamics of Zn(II) ions adsorption onto the magnetic nanoadsorbents indicated that the adsorption was spontaneous, endothermic and physical in nature. The surface morphology of magnetic nanoadsorbent by Scanning Electron Microscopy (SEM) and elemental analysis by Electron Diffraction Spectrometry (EDS) technique. The structural and photo catalytic properties of magnetic nanoadsorbent were characterized using X-ray Diffraction (XRD) and Fourier Transform Infrared (FTIR) techniques. Also the magnetic properties of synthesized magnetic nanoadsorbent were determined by Vibrating Spinning Magnetometer (VSM).

The employed magnetic nanodsorbent for Zn (II) ion removal was influenced by various parameters such as Initial pH, Initial Zn (II) concentration, contact time and adsorbent dose. The maximum adsorption Zn(II) ions on magnetic nanoadsorbent occurred at pH 5.5.The SEM analysis study of magnetic nanoadsorbent before and after treatment shows distinct removal of Zn(II) ions and adsorbent shows nanosized particles. Also EDX study indicates the Zn(II) ions were clearly adsorbed from EDX analysis data. The XRD result shows the different 2θ peaks which shows different plane and size of magnetic nanoadsorbent calculated by Scherrer formula. The VSM analysis of magnetic nanoadsorbent shows sufficient magnetic properties. Equilibrium and thermodynamic study of Zn (II) ion removal shows the adsorption process is spontaneous and endothermic.
The detail results of Zinc removal were described and discussed in section-IV of Chapter-3.

Section-V

Detection of Metals from the Wastewater (Industrial or Sewage) by ICP-AES.

Human health is greatly affected by exposure to Toxic heavy metals through drinking water. Arsenic is a carcinogen and its consumption can negatively affect the gastrointestinal tract, cardio-vascular and central nervous systems. Exposure to heavy metals has been linked with developmental retardation, various cancers, kidney damage and even death. A legacy of incident tells us about the seriousness of high levels of exposure to some metals, especially cadmium and methyl mercury. In the 1950s, chronic poisoning from rice coupled with dietary deficiencies caused epidemic of kidney damage and a painful skeletal disease among middle – aged women in Japan; the itaitai disease. Also in Japan, mercury poisoning from fish in a polluted bay became known as Minimata disease. Industrial pollution seriously threatens the quality of water resources and the environment in the world.

Wastewater treatment is essential to allow human and industrial effluents to be disposed without bringing danger to human health as well as to prevent unacceptable damage to the natural environment. Heavy metals pollution of water is a major environmental problem in the modern world faces. Common pollutants related to the kinds and amounts of urban and industrial discharges as well as to the contribution of anthropogenic sources, enter into the aquatic environment (many of which are considered potent toxicants capable of producing a wide spectrum of adverse health effects such as chloracne, carcinogenicity, disruption of the endocrine System, and antiestrogen effects) in both dissolved and particulate forms. The removal of toxic heavy metals from industrial wastewater is essential for the environmental pollution control. Many industries release heavy metals such as Zn, Cd, Cu and Cr in wastewater. Heavy metals can cause brain damage and many diseases in human beings. They cannot be degraded easily and their cleanup usually requires their removal. Therefore, the direct release of reused wastewater for the irrigation of agriculture and horticultural is viewed as posing potential
risk to human health. In this section the monitoring of the current status of the wastewater pollution containing toxic heavy metals in Industrial effluents.

The methods was described and discussed in one subsection.

A) Detection of Toxic Heavy Metals from the Industrial or Sewage wastewater by ICP-AES.

**A) Detection of Toxic Heavy Metals from the Industrial or Sewage wastewater by ICP-AES**

Today's industrial and sewage wastewater pose a serious environmental problem and pollute water bodies very badly which affects the flora and fauna of aquatic life. It is a basic need to know the concentration of heavy metals in wastewater before it, leaving into the big water bodies. This study focuses on the detection of heavy metals present in the industrial or sewage wastewater by well developed technique ICP-AES, which can detect the metals concentration up to 0.01 mg present in the wastewater the same sample were characterized by FTIR which shows the different IR frequencies of metals. Extraction of heavy metals by Digestion of wastewater sample in conc. $\text{HNO}_3$ and conc. HCl, concentrates the sample up to required quantity for ICP-AES detection technique. In this study the digestion of wastewater sample in Conc. Nitric acid and hydrochloric acid for detection of toxic heavy metals from the industrial or sewage wastewater is a reliable method of sample preparation for metal detection by ICP-AES technique.

To reduce the uncertainty in quantifying contaminant discharges to UWW (Untreated Waste Water) by identifying and surveying specific sources to determine the potential for controlling inputs particularly from small commercial sources and medical establishments. To establish the extent and variability of contaminant entry into UWW by catchment investigations in relation to precipitation frequency and changes in sludge quality. To critically and independently review the fate, behaviour, degradability, toxicity and environmental consequences of alternative surfactant and plasticing compounds, in collaboration with the related chemical manufacturing industries, to inform decisions of the benefits and disadvantages of product substitution in detergent formulations and plastics manufacture. To determine the extent of volatilisation-deposition cycling of
persistent organic pollutants in the environment, identifying the processes controlling the extent and magnitude of diffuse inputs of these substances to UWW and to provide long-term predictions of changes in release patterns and the consequences for UWW and sludge. To develop a consistent statistical and reporting protocol for national chemical composition data presented in surveys of sewage sludge quality. The physico-chemical investigation reveal that the Industrial and sewage wastewater sample in GIDC-Vapi was generally exceeds the permissible limit of WHO and hence it was very harmful to human being and aquatic life.

The detail results of metals detected by ICP-AES were described and discussed in section-V of Chapter-3.

Section -VI

Study the Application of Prepared Novel Magnetic Nanoadsorbent.

Water bodies comprising both polluted wastewaters and groundwater from seas, rivers and lakes are of special concern to people working in water purification and the environment in general. In this regard water quality control standards and regulations against hazardous pollutants have become stricter in many countries. With the increasing revolution in science and technology, there was a bigger demand on opting for newer chemicals which could be used in various industrial processes. Organic dyes came up as one of the many new chemicals which could be used in many industrial activities. Due to the extensive use of these dyes in industries, they have become an integral part of industrial effluent. In fact, of the 450,000 tons of organic dyes annually produced worldwide, more than 11% is lost in effluents during manufacture and application processes.

It is well known that soluble azo dyes when incorporated into the body are split into corresponding aromatic amines by liver enzymes and intestinal flora, which can cause cancer in human. The textile industry produces large quantity of highly colored effluents, which are generally toxic and resistant to destruction by biological treatment methods. Therefore, it is necessary to find an effective method to remove color from textile effluents. Dye pollutants from textile dye industries are an important source of environmental contamination. The of dyes are currently used in textile industry is about 10,000. It is estimated that 1-155 of the dyes are lost during the processes and is released
in wastewater. The release of this colored wastewater poses a major problem for the industry as well as a threat to the environment. Dye pollutants are generally resistant to biological degradation.

The discharge of dyes in the environment is worrying for both toxicological and esthetical reasons as dyes impede light penetration, damage the quality the receiving streams and are toxic to food chain of organisms. However, commercially available activated carbon is still considered expensive. The world-wide high level of production and use of generating colored wastewater, which gives of environmental concern. Textile companies, dye manufacturing industries, paper had pulp mills, tanneries, electroplating factories, distilleries, food companies and a host other industries discharge colored wastewater.

This section focus on synthesis of magnetic nanoadsorbents and their applications in photocatalytic removal of organics such as dyes and Phenol from effluents.

The methods described and discussed in three subsections.
C) Removal of Hazardous Ponceau-S Dye by Magnetic Nano Adsorbent $\text{Fe}_2\text{O}_3$ from Aqueous Solution.

Phenols are toxic organic compounds and which badly affects the flora and fauna of the biosphere because phenols are persistent pollutant found in wastewater from many industries. In present research article the photocatalytic removal of O-nitro Phenol by synthesized Magnetic Nanoadsorbents (MNA) carried out under photocatalytic reactor. The MNA were synthesized by Co-precipitation method required short period of time. The photocatalytic reactor manually assembled in laboratory. The U.V irradiation found to be effective. The different parameters have been studied like initial concentration of O-nitro Phenol, temperature, contact time, adsorbent dose and pH. The effective removal of O-nitro Phenol by MNA at optimum pH 1.5 to 2.5.

The employed MNA was characterized by SEM (Scanning Electron microscopy), XRD (X-ray Diffraction) and FTIR (Fourier Transfer Infrared Spectroscopy). The Present removal study well fitted for Freundlich and Langmuir adsorption isotherm. A kinetics and equilibrium studies were also carried out by using MNA. In this experimental research the desorption study of MNA also shows good results, reusability of MNA were possible.

In the present investigation the MNA were prepared from the Salt of Fe$^{+2}$ and Fe$^{+3}$have been used as precursor MNP synthesis employed for the photocatalytic removal of O-nitro phenol from the aqueous solutions. Adsorption was influenced by various parameters such as Initial pH, Initial O-nitro phenol concentration, contact time and adsorbent dose. The maximum adsorption of O-nitro phenol by MNA occurred at pH 1.5 to 2.5 for the O-nitro phenol. Removal efficiency increased with decreasing the O-nitro phenol concentration and increasing dose of adsorbent. The Langmuir and Freundlich adsorption isotherm models were used for the description of the adsorption equilibrium of O-nitro phenol onto MNA.

The data were good agreement with Langmuir and freundlich isotherms. It was shown that the adsorption of O-nitro phenol on to MNA best fitted by pseudo first order and pseudo second order kinetics. The adsorbent were characterized by SEM and FTIR to detect adsorption capacity by SEM and by the IR detect frequencies of different
functional groups of MNA. This adsorption process is very important to liable for the textile and organic synthesis industrial wastewater treatment.

The detail results of O-Nitro Phenol removal were described and discussed in section-VI of Chapter-3.


The magnetic nonmaterial’s finds various applications in the field of nanotechnology especially in the wastewater treatment. In this experimental research the magnetic nano thin film were employed for industrial wastewater pollution specially in photocatalytic degradation of Rhodamine 6G. The results shows that Rhodamine 6G is successfully removed from aqueous solution in photocatalytic technique using magnetic nano thin film. The magnetic nano thin film synthesized on glass substrate by spray pyrolysis method by spraying the aqueous solution of precursor of Fe$^{3+}$ chloride and Fe$^{2+}$ chloride hot plate by adjusting temperature. The various parameters are also studied such as Initial concentration of dye, contact time, pH etc. The optimum conditions for degradation of dye are pH=3.5, Initial concentration 35 mg/L and contact time 45 minutes. The synthesized nano thin film was characterized by Scanning Electron Microscopy (SEM), X-ray Diffraction (XRD) which shows effective results.

Spray pyrolysis is a versatile and effective technique to deposit metal oxide films. The films shows good homogeneous structure and nanostructure as investigated by XRD and SEM analysis results. The quality and properties of the films depend largely on the process parameters. The most important parameter is the substrate surface temperature. The higher the substrate temperature, the rougher and more porous are the films. If the temperatures are too low the films are cracked. The deposition temperature also influences the crystalline, texture, and other physical properties of the deposited films.

The precursor solution is the other important spray parameter, which affects the morphology and the properties of the deposited films. In addition, the film morphology and properties can be drastically changed by using various additives in the precursor solution. It is often suggested that a modified CVD process occurs close to the surface of
the substrate. However many observations contradict the involvement of a model with a CVD character. Further efforts are necessary to clarify the model for film deposition.

The obtained results and detail Rhodamine 6G dye removal were described and discussed in section-VI of Chapter-3.

C) Removal of Hazardous Ponceau-S Dye by Magnetic Nano Adsorbent Fe$_2$O$_3$ from Aqueous Solution.

The photodegradation of Ponceau-S dye was investigated using UV radiation in presence of nanosized Fe$_2$O$_3$. Removal efficiency of Ponceau-S was sensitive to the operational parameters such as dye concentration, catalyst dose, pH, contact time, TOC and COD. The photocatalytic treatment of red colored Ponceau-S dye by magnetic nano semiconductor (Fe$_2$O$_3$) is an effective, economic and faster mode. The kinetics and isotherm studies were carried out. A simple kinetics model was proposed which confirmed pseudo second order reaction. Langmuir isotherm fitted this study. The optimum conditions for the degradation of the dye were initial concentration 50 mg/L, pH 8, contact time 20 minutes and catalyst dose 5 g/L of Fe$_2$O$_3$. The semiconductor photocatalyst was also carried out for SEM and XRD analysis which confirms the utilized semiconductor was nanosized.

The result of the present study shows that the Nano sized Fe$_2$O$_3$ can be used as an effective photo-catalyst for the removal of Ponceau-S from aqueous solution. The kinetics model well fit with the pseudo second order and adsorption followed the Langmuir isotherm. The adsorption capacity of Fe$_2$O$_3$ for Ponceau-S was found to be the equation of adsorption is practically achieved in 20 minutes. The degradation of Ponceau-S was measured by TOC and COD determination. The almost complete removal of dye can be achieved by using an appropriate dose of photo-catalyst and pH from aqueous solution.

The detail results of Ponceau-S dye removal were described and discussed in section-VI of Chapter-3.
Section-VII
Statistics of Collected Physico-Chemical Results

Textile Wastewater Characteristics Composite textile wastewater is characterized mainly by measurements of biochemical oxygen demand (BOD), chemical oxygen demand (COD), suspended solids (SS) and dissolved solids (DS). Wastewater is around 0.25 that implies that the wastewater contains large amount of non biodegradable organic matter. In small communities, wastewater treatment facilities may consist of individual septic systems, simple collection systems that directly discharge effluent to surface waters, or municipal lagoons that are emptied annually. These facilities usually treat and disperse the waste as close as possible to its source, thus minimizing operational costs and maintenance requirements.

The longer the waste can sit in a lagoon before being discharged, the less likely it will be to contaminate drinking water sources. Some communities store the waste in lagoons, but others release the waste directly into water sources. Lagoons are reservoirs in the ground that store waste for a time until it is discharged, either to the soil or a water body. Shallow lagoons, that are less than 1.5 metres deep, are used for primary treatment, which allows the solid waste to settle to the bottom of the lagoon over a period of 6 to 20 days. Shallow lagoons, however, cannot effectively remove the majority of contaminants that pose problems for ground and surface waters. Deep lagoons, which are more than three metres deep, can provide long-term storage and treatment for six months to one year. Many lagoons in small communities are emptied once per year. Rural communities often make use of surrounding land to dispose of wastewater. When the soil is adequate, and there are no water sources nearby, the bacteria in the soil can remove and break down the contaminants in wastewater. Due to the availability of land in many rural areas, this can be an effective method to treat wastewater.

In this section the evaluation of current status physicochemical parameters of the Industrial effluents and statistical evaluation of physicochemical parameters from their obtained data.

The methods was described and discussed in one subsection.
B) Physico-Chemical Status and Statistical Evaluation of Industrial wastewater.
A) Physico-Chemical Status and Statistical Evaluation of Industrial wastewater.

Flora and fauna along with human health is greatly affected by exposure to toxic heavy metals through drinking water. The toxic heavy metals such as Arsenic (As), lead (Pb), chromium (Cr), zinc (Zn), cadmium (Cd), mercury (Hg), nickel (Ni) and copper (Cu) are widely used for production of color pigments of textile dyes and printing industries. After use of these toxic metals are flashing away with industrial effluents (wastewater). These metals are carcinogenic and its consumption can negatively affect the gastrointestinal tract, cardiovascular and central nervous systems of the human body as well as badly affects water eco-system. The physico-chemical parameters determined to be color, odor, turbidity, COD, BOD, pH, hardness, alkalinity, electrical conductivity, TDS, salinity, chloride content and concentrations of ions like calcium, magnesium, fluoride and nitrates.

The obtained analyses results were compared with the drinking water standards of the ICMR and WHO (1993). The statistical parameter analysis, such as values of mean, standard deviations and correlation Co-efficient (r) were calculated.

The present investigation has led to conclude that the quality of water samples studied was acceptable for the majority of the physicochemical parameters, but as TDS values of most of the samples was violating the desirable limit suggested by ICMR, the water should be treated properly before it's drained into water bodies to avoid probable adverse effects on flora and fauna of the ecosystem. Therefore, the public should be made aware of water quality and careful management of industrial and sewage wastewater. Water quality also should be monitored continuously for the welfare of the human being.

The detail results of stastical analysis were described and discussed in section-VII of Chapter-3.