4. GAS CHROMATOGRAPHY-MASS SPECTROMETRY
(GC-MS) STUDY OF INDUSTRIAL EFFLUENT

4.1 INTRODUCTION

Increasing urbanization and industrialization resulted in extreme increase in the volume of wastewater production around the world. Industries continuously release effluents into rivers and other common sources of water; this industrial wastewater is the main source which pollutes water (Mattioli et al., 2002; Patil and Shrivastava, 2006; and Joshi and Santani, 2012). The wastewater generated from many industrial estates is complex in nature because of the variability in the process system producing organic and inorganic load in the wastewater. The scarcity of water resources around the world increases the demands on the use of secondary sources, such as wastewater. Such contamination is introduced to the aquatic environment by various anthropogenic activities, such as fishery and agriculture activities, production, refining or use of petroleum products (Schwarzbauer et al., 2001; Heim et al., 2004).

The constituents in industrial effluents can represent a high diversity with respect to their physical and chemical properties and molecular structures as well as concentration levels. Their unique appearance within a spatially defined area receiving wastewater discharge from a particular industrial source allows detection of compounds that can be characteristic for a certain industrial branch or production process. Specific character of industrial effluents can be represented also by high contaminant concentration values and their strong fluctuations, and a wide range of chemical substances because of the high molecular variety of the types of production activities. The contamination from municipal discharges has been investigated to the large extent and the environmental behavior of a wide range of environmental pollutants including pharmaceuticals (Heberer & Stan, 1998; Larsson et al., 2007; Boillot et al., 2008; Quinn et al., 2008; Zhang et al., 2008), constituents of personal care products (Dsikowitzky et al., 2002), polymer additives, such as flame retardants, plasticizes, etc. (Meyer and Bester, 2004), and detergents (Schwuger, 1996) in surface waters has been described in detail.
Organic pollution from industrial point sources takes a significant part in the overall anthropogenic impact to the natural ecosystems due to their persistence, bioaccumulation potential and significant adverse effects on humans and aquatic organisms. Various studies, performed on the detailed description of effluent composition and the determination of various toxic components in the industrial effluents discharged to the surface waters, served as an important contribution to the estimation of potential risks to the aquatic environment.

Furthermore, the ecotoxicological studies (fish, Daphnia, algae growth and luminescent bacteria tests) have been performed with the purpose of the evaluation of potential harmful effects of the wastewater constituents from various industrial branches to the aquatic organisms. Many authors stated that industrial effluent having toxicity against living organism such as algae, Daphnia, Lemma and fishes. Yoo et al., (2013) reported that effluent water collected in January-August 2009 from textile and leather industry showed toxicity towards Daphnia magna and Ulva pertusa. The industrial effluent inhibited the feeding of D. magna and Moina macrocopa, also it showed acute toxicity to the tested organism (Yi et al., 2010). Lee et al., (2016) reported that mixture of industrial effluent showed toxicity against fish (Common carp, Cyprinus carpio) and Daphnia similis. Among the effluent more than 60% was toxic to D. similis and less than 30% toxic against common carp. Effluent from industries consider as a major aquatic pollutants. The effluent collected from the industries in four seasons. The concentration of chemical was high in winter and spring than other 2 season. The collected chemicals were toxic to algae, Daphnia and found more toxic to mortality and developmental abnormalities in zebrafish embryos (Bielen et al., 2017).

Metalloid pollutants, boron, is toxic to macrophyte Lemma minor and L. gibba; it affect the growth rate, frond number and dry biomass of Lemma (Gür et al., 2016). Teta and Naik (2017) have observed that industrial and municipal effluent more frequently pollute the aquatic environment. These effluent affect the reproduction capacity of aquatic organisms; furthermore, decline the fertilization and reduced the breeding of the zebrafish.
Industrial effluent exhibited genotoxicity (nuclear abnormality) against freshwater fish *Oreochromis niloticus* (Weldetinsae et al., 2017). Radić et al., (2010) stated that industrial effluent exhibited inhibition of growth rate (frond number & Biomass, chlorophylls content) also increased peroxidase activity, tail extent (comet assay) of *Lemna*. The chronic toxicity of Industrial effluent was studied against common carp on the 21-day exposure period. The treatment affects the molecular pathway of the tested fishes also carbohydrate, lipid metabolism and digestive enzyme’s activity (Moens et al., 2007). The duckweed, *Lemna* is highly sensitive to effluents treatment also is the most suitable bio-indicator (Taraldsen and Norberg-King, 1990).

Brack (2003) stated that various chemicals were contaminated surface water, sediments, soils and air particulate. Without prior data of toxicants, toxic analysis is not easy; of these effect-directed analysis (EDA) was developed, which is based on a combination of bio-testing, fractionation procedures and chemical analytical methods. The available methods of EDA for organic toxicants in complex mixtures. While EDA is a powerful tool to identify specifically acting individual toxicants close to the source of emission, it is inappropriate for screening purposes and often may fail in remote areas where the concentrations of specific toxicants are too low relative to the nonspecific toxicity of the whole mixture of natural and anthropogenic compounds. The biological tools have to be carefully selected with respect to their ability to detect specific effects and their significance in hazard assessment. Sophisticated chemical tools are required to identify individual toxicants in mixtures of thousands of compounds, which are typical for contaminated environments. The method of effluent analysis was belonged to four categories, they were physical and chemical properties, inorganic metals analysis, inorganic non-metallic analysis and organic analysis (Rojas and Ojeda, 2005).

Nevertheless, nowadays there is a lack in systematic investigation on the distribution of specific industrial constituents in the surface waters with regard to the tracing of emission sources based on the characteristic behavior of the discharged compounds in the affected river system. Hence, the present study, GC-MS analysis of industrial effluent was aimed to conduct highly polluted industrial estate of Sachin, Surat district of Gujarat, India.
4.2 MATERIALS AND METHODS

4.2.1 Liquid-Liquid Extraction

The extraction method used has been previously described in detail (Dsikowitzky et al., 2002). Briefly, a sequential liquid–liquid extraction procedure was applied to approximately 100 mL aliquots of the industrial effluents. 100 mL of sample and dichloromethane were transferred to the reparatory funnel. The funnel was shaken vigorously, for 4-5 minutes with intermittent release of pressure. After shaking, the content was left undisturbed for next 4-5 minutes, for layer separation. The organic layer was poured through a layer of anhydrous sulphate and collected in a clean and dry flask. The extraction process of the mother liquor was repeated twice, and organic layer was collected. The organic layer was concentrated by rotary evaporator under reduced pressure to approximately 1 mL. The samples were used for GC-MS analysis.

4.2.2 Gas Chromatography/Mass Spectrometry Analysis

All sample extracts were analyzed on an Agilent Technologies, Model 7890 gas chromatograph with 5977A mass spectrometer. Separations were done using capillary column HP-5MSI (30 m x 250 μm id, 0.25 μm). A 1-μL volume of sample extract was injected in splitless mode (0.7 min) at an injection port temperature of 290 °C. The oven temperature was programmed as follows: initial temperature 40 °C, (hold 2.0 min) then ramped at degree celsius per minute (15°C/min) to 280 °C (hold 42 min). The electronic pressure control was set to deliver a constant flow of helium carrier gas of mL/min. The mass spectrometer was set as follows: 150 °C analyzer, 230 °C source, 290 °C interface, and electron ionization mode at 70 electron volts. Full-scan data was collected from 50 to 550 atomic mass units. The analysed data was compared with library data (NIST 14).
4.3 RESULTS AND DISCUSSION

The physico-chemical analysis of the collected effluents have been discussed in section 3.

May 2014: Site 1

The collected effluents was analysed in GC-MS, the chromatogram showed 10 peaks (Figure 4.6.1), when compared to digital library (NIST 14), 6 peaks only showed similar compounds and other 4 peaks such as 6, 7, 9 and 10 were not correlated with any compounds, when compared to NIST 14. Table 4.6.1 exhibited analysis of compounds from site 1. Maximum 8 possible compounds was recorded in peak 1 at retention time (RT) of 12.083 min. with 31.82% area followed by peaks 2 and 3 showed 6 possible compounds. The lower number of possible compounds were recorded in peaks 4 & 8 at retention time 23.555 and 26.02 min., respectively. The detected possible compounds were Phenol, 2,4-dichloro-; Phenol, 2,6-dichloro-; Phenol, 2,5-dichloro; Phenol, 2,4-dichloro-, acetate; 2,6-Dichlorophenol, isopropyl ether; Hydrazinecarboximidamide, 2-[2-(2,6-dichlorophenoxy)ethyl]-; 2,3-Dichlorophenol, isopropyl ether; Hydrazinecarboximidamide, 2-[2-(2,6-dichlorophenoxy)ethyl]-; 2,3-Dichlorophenol, isopropyl ether; Carbonic acid, ethyl 2,5-dichlorophenyl ester; Chloroxylenol; 4-Chloro-2,6-dimethylphenol; Carbanolate; 4-Chloro-2-methylbenzyl alcohol; Sulfone, 4-tolyl 4-methylene-(E)-2-phenylcyclopentyl; Methyl _-methoxyphenylacetate; Hexadecane; Tridecane; Undecane, 2,3-dimethyl; Heptadecane, 2,6,10,14-tetramethyl; Pentadecane, 5-methyl; Heptyl tetradecyl ether; Tridecane, 6-methyl-; Octadecane; 9-Octadecenamide, (Z)-; 13-Docosenamide, (Z)-; (t-Butyl-dimethylsilyl)[2-methyl-2-(4-methyl-pent-3-enyl)-cyclopropyl]-methanol; Adipic acid, 2-ethylhexyl tetradeceyl ester; Di-n-decylsulfone; Heptasiloxane, 1,1,3,3,5,5,7,7,9,9,11,11,13,13-tetradecamethyl and Octatriacontyl pentafluoropropionate; Tetrapentacontane, 1,54-dibromo present in effluents collected from site 1 of May 2014.
Chapter 4

May 2014: Site 2

Figure 4.6.2 showed GC-MS analysis of effluents collected from site 2 of May 2014. Table 4.6.2 showed the possible compounds present in the analysed effluents. Maximum 10 peaks obtained from the analysis, 8 different retention time showed similar possible compounds during library comparison. There was no similar compounds found for peaks 1 and 3. Some of the possible compounds were Oxalic acid, ethyl 2-isopropylphenyl ester; Spiro-1-(cyclohex-2-ene)-2’-(5’-oxabicyclo[2.1.0]pentane), 1’,4’,2,6,6-pentamethyl; o-Isopropylphenetole; Cyclohexane, 1,1,4,4-tetramethyl-2,5-dimethylene; 1,3-Cyclohexadiene-1-carboxylic acid, 2,6,6-trimethyl-, ethyl ester; Benzestrol; 1-(p-Methoxycarbonylphenyl)-3-(p-ethoxyphenyl) triazene; 3-Octen-5-yn, 2,2,7,7-tetramethyl-, (E)-; 1H-Pyrazole, 5-chloro-1-methyl-3-trifluoromethyl; 6-Acetyl-8-(2-chloroethyl)-5-hydroxy-6,7-diazaspiro[3.5]non-7-ene; 1H-Cyclopenta(b)quinoline, 2,3-dihydro-9- amino; Benzestrol; Phenol, 4-(1,1-dimethylpropyl); Hexestrol; Carbamic acid, N-[1,1-bis(trifluoromethyl)ethyl]-, 4-(1,1,3,3-tetramethylbutyl)phenyl ester; 1,3-Bis(4-formylphenoxy)propane; Benzene, 1-ethoxy-4-[2-(4-pentylcyclohexyl)ethyl]-; Benzestrol; Tricyclo[3.1.0.0(2,4)]hexane, 3,3,6,6-tetraethyl-,trans; 1,3-Bis(4-formylphenoxy)propane; 1,3,5-Trimethyladamantane; 1,3,3-Trimethyl-2-(2-methyl-cyclopropyl)-cyclohexene; Oxalic acid, ethyl 2-isopropylphenyl ester; (1R,2R,5R,E)-7-Ethylidene-1,2,8,8-tetramethylbicyclo[3.2.1]octane; Cyclohexane, 1,1,4,4-tetramethyl-2,5-dimethylene; 3-Octen-5-yn, 2,2,7,7-tetramethyl-, (E)-; 3-Octen-5-yn, 2,2,7,7-tetramethyl; 1,3-Cyclohexadiene-1-carboxylic acid, 2,6,6-trimethyl-, ethyl ester; 2-Butanone, 4-(2,6,6-trimethyl-2-cyclohexen-1-ylidene); Phenol, 4-(1,1-dimethylpropyl)-; phenol, 2-(1,1,3,3-tetramethylbutyl)-; Carbamic acid, N-[1,1-bis(trifluoromethyl)ethyl]-, 4-(1,1,3,3-tetramethylbutyl)phenyl ester; 4-tert-Butylphenyl acetate; Hexestrol; Benzene, 1-ethoxy-4-[2-(4-pentylcyclohexyl)ethyl]-; 1,3-Cyclohexadiene, 1,3,5,5,6,6-hexamethyl-; 3,5,7-Nonatrien-2-one, 8-methyl-7-(1-methylethyl)-, (E,E)-; 1,3-Cyclohexadiene, 1,3,5,5,6,6-hexamethyl; Cyclohexane, 1,1,4,4-tetramethyl-2,5-dimethylene- andAdamantane, 1-isothiocyanato-3-methyl; present in effluent collected from site 2 of May 2014.
May 2014: Site 3

In the present study collected effluent was analysed in GC-MS and the chromatogram exhibited 10 major peaks (Figure 4.6.3) among the peak 4 only match with library. The 2\textsuperscript{nd} peak exhibited four compounds, Phenol, 3-methyl; Carbamic acid, methyl-, 3-methylphenyl ester; Benzyl alcohol and m-Cresyl acetate. The 3\textsuperscript{rd} peak produced the possible compounds like Phenol, 2,4-dichloro-; Phenol, 2,4-dichloro-, acetate; Phenol, 3,4-dichloro-, acetate and Phenol, 2,6-dichloro-, acetate. The 6\textsuperscript{th} peak showed as possible compounds of 2-Naphthalenol; Furan, 3-phenyl-; Benzofuran, 2-ethenyl; 1-Naphthalenol, acetate; 1-Naphthyl n-propylcarbamate; Cinnoline, 3-methyl and 2-Naphthyl propionate. The 10\textsuperscript{th} peak produced similar to following compounds such as 4-Amino-3-methylbenzoic acid; 3-Amino-4-methylbenzoic acid; 5-Butyl-2-pyridinecarboxylic acid-1-oxide and Benzene, 1,4-dimethyl-2-nitro (Table 4.6.3).
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September 2014: Site 1

Figure 4.6.4 showed GC-MS analysis effluent report, the chromatogram showed 10 major peaks during analysis period of 60 min. Table 4.6.4 among the 10 peaks, only 9 peaks exhibited similar compound during library search. The possible compounds were Bicyclo[4.2.0]octa-1,3,5-triene; Styrene; Benzene, (2-nitroethyl)-; 2-Pyridinecarbonitrile; Sydnone, 3-phenyl; 1H-Benzotriazole, 4-methyl; Benzene, 3-pentenyl-, (Z)-; 1-Benzyl-1,2,3-triazole; Benzene, 1,1’-(1,2-dimethyl-1,2-ethenediy1)bis-, (Z)-; Benzene, 1,1’-[1-(2,2-dimethyl-3-butanyl)-1,3-propanedi1]bis-, Benzene, 1,1’-(3-methyl-1-propene-1,3-diyl)bis; 3-Nitroso-2-phenyl-4-(phenylmethyl)-5-oxazolidinone; Benzene, 1,1’-(1,2-cyclobutanedi1)bis-, trans-; 2,6-Pyridinedicarboxylic acid, isobutyl phenethyl ester; p-Toluenesulfonic acid phenethyl ester; Benzene, 4-azido-1-methyl-2-nitro-; 2-Methylbenzyl benzoate; Benzeneacetic acid, 2-phenylethyl ester; 6-Dimethylaminomethyltricyclo[8.2.2.2.(4,7)]hexadeca-1(13),4,6,10(14),11,15-hexaen-5-ol; Benzeneethanamine, N-[(4-hydroxy)hydrocinnamoyl]-; Cyclopentene-1-carboxylic acid, 4-[2-(diphenylmethyl)-2-propen-1-yl]-, methyl ester; 1-benzylindole; Benzenemethanamine, N-hydroxy-N-phenylmethyl); 2-Benzylselanyl-1H-benzozimidazole; Benzenemethanamine, N-(phenylmethylene)-; Benzene, 1,1’-(2-methyl-2-propenylidene)bis-; 1,2-Diphenyl-1-isocyananoethane; (2,3-Diphenylcyclopropyl)methyl phenyl sulfoxide, trans-; Thiocarbamic acid, N,N-dimethyl, S-1,3-diphenyl-2-butetyl ester; Methadone N-oxide; 3,1-Benzoxazepine, 5-methyl-2-phenyl; Phenanthridinium, 5,6-dimethyl-, iodide; Anthracene, 9-ethyl-9,10-dihydro-10-t-butyl-; Naphthalene, 1,2,3,4-tetrahydro-1-phenyl-1-Propene, 3-(2-cyclopentenyl)-2-methyl-1,1-diphenyl; Benzene, 1,1’-[2-methyl-2-(phenylthio)cyclopropylidene]bis-; Thiocarbamic acid, N,N-dimethyl, S-1,3-diphenyl-2-butetyl ester; Phenanthridinium, 5,6-dimethyl-, iodide; 1,11-Diphenyl-1,3,5,7,9-undecapentaene; 2-(n-Propyl)oxybenzylidine acetophenone; Benzo[h]quinoline, 2,4-dimethyl-; Anthracene, 9,10-diethyl-9,10-dihydro-; 1-benzylindole; Dibenzo[b,E]-8-azabicyclo[3,2,1]octane, N-[N-[3-hydroxypropyl]aminocarbonyl]-; Benzenamine, N-[(2-(1-methylethyl)phenyl]phenylmethylene]-; 4-Phenyl-3,4-dihydroisoquinoline; 2-Cyclohexen-1-one, 4,4-diphenyl; 5H-
dibenzo[a,d]cyclohepten-5-amine; Methadone N-oxide; Cyclopentene-1-carboxylic acid, 4-[2-(diphenylmethyl)-2-propen-1-yl]-, methyl ester; (2,3-Diphenylcyclopropyl)methyl phenyl sulfoxide, trans-; Thiocarbamic acid, N,N-dimethyl, S-1,3-diphenyl-2-butenyl ester; 1-Propene, 3-(2-cyclopentenyl)-2-methyl-1,1-diphenyl-; Cyclohexane, 1,4-bis(diphenylmethylene)-; Benzimidazole, 2-benzyl-1-(4-chlorophenylsulfonyl)-; benzene, 1,1',1"-[5-methyl-1-pentene-1,3,5-triyl]tris-; Indolizine, 2-(4-methylphenyl)-; 2-(2-Methylpropyl)oxybenzylidene acetophenone and Cyclohexane, 1,4-bis(diphenylmethylene) present in the sample collected from site 1 of September 2014.
Chapter 4

September 2014: Site 2

Figure 4.6.5 shows the GC-MS analysis of effluent which was collected from site 2 of September 2014. Totally 10 major peaks were exhibited from the chromatogram, while possible compounds were present for only 6 peaks. Benzene group was found in all peaks as possible compound. Some of other possible compounds were Bicyclo[4.2.0]octa-1,3,5-triene; Benzene, 4-azido-1-methyl-2-nitro--; Cyclobutane, 1,3-diphenyl-, trans; Benzene, (1,2-dibromoethyl)--; 3-(3-Pyridyl)-5-phenylisoxazoline; N-Ethylbenzimidoyl bromide; Naphthalene, 1,2,3,4-tetrahydro-2-phenyl--; Benzene, 1,1'-[1-(2,2-dimethyl-3-butyl)-1,3-propanediyl]bis--; Naphthalene, 1,2,3,4-tetrahydro-1-phenyl--; Benzene, 1,1'-(3-methyl-1-propene-1,3-diyl)bis--; 2-Ethyl-5-methyl-3,3-diphenylpyrrolidine; 1-Propene, 2-(2-methylphenyl)-1-phenyl-, (Z); Benzene, 1,1'-(2-methyl-1-propenylidene)bis--; Benzene, 1,1'-(1-butenylidene)bis--; N-Benzyl-1H-benzimidazole; Benzene, 1,1'-(1,2-dimethyl-1,2-ethenediy)bis--, (E)--; Benzene, 1,1'-(1,2-diisocyano-1,2-dimethyl-1,2-ethanediyl)bis; 1-Propene, 2-(3-methylphenyl)-1-phenyl-, (Z)--; 3-(Benzylthio)acrylic acid, methyl ester; Benzyl-N-(1-benzyl-2-hydroxyethyl)-N-methylcarbamat; 2-Pentenoic acid, 5-phenyl-, ethyl ester, (E)--; Benzene, 1,1'-(1,2-cyclobutenediy)bis--, trans--; Benzene, 1,1'-(1,2-cyclobutenediy)bis--, cis--; Butanedioic acid, phenyl; Naphthalene, 1,2,3,4-tetrahydro-2-phenyl; Benzeneacetic acid, 2-phenylethyl ester; Benzene, 4-azido-1-methyl-2-nitro--; 2-Methylbenzyl benzoate; benzene, 1,1',1"-[5-methyl-1-pentene-1,3,5-triy]tris--; 1,2-Diphenyl-1-isocyanoethane; 4-[Benzylamino]benzo-1,2,3-triazine; Benzonitrile, m-phenethyl; trans-[2,3-Diphenylcyclopropyl)methyl phenyl sulphide; Isoxazole, 5-chloro-4-(2-phenylethyl)--; 1,11-Diphenyl-1,3,5,7,9-undecapentaene; N-Benzyl-N-(3-phenylprop-2-en-1-yl)-tosylamide; Nitron; 1-Propene, 3-(2-cyclopentenyl)-2-methyl-1,1-diphenyl--; (2,3-Diphenylcyclopropyl)methyl phenyl sulfoxide, trans--; Thiocarbamic acid, N,N-dimethyl, S-1,3-diphenyl-2-butenyl ester; Cyclopentene-1-carboxylic acid, 4-[2-(diphenylmethyl)-2-propen-1-yl]--, methyl ester; Methadone N-oxide; benzene, 1,1',1"-[5-methyl-1-pentene-1,3,5-triy]tris--; 1,11-Diphenyl-1,3,5,7,9-undecapentaene; 1-Propene, 3-(2-cyclopentenyl)-2-methyl-1,1-diphenyl; (2,3-Diphenylcyclopropyl)methyl phenyl sulfoxide, trans;
Thiocarbamic acid, N,N-dimethyl, S-1,3-diphenyl-2-butenyl ester; Cyclopentene-1-carboxylic acid, 4-[2-(diphenylmethyl)-2-propen-1-yl]-, methyl ester; Methadone N-oxide; Benzenamine, N-[[2-(1-methylethyl)phenyl]phenylmethylene]-; benzene, 1,1',1''-[5-methyl-1-pentene-1,3,5-triyl]tris-; 2-(n-Propyl)oxybenzylidene acetophenone; Cyclopropanecarboxamide, 2,2-bis(4-methylphenyl)-N-(2-fluorophenyl)- and 1,11-Diphenyl-1,3,5,7,9-undecapentaene (Table 4.6.5).
September 2014: Site 3

Figure 4.6.6 showed chromatogram of effluent collected from site 3 on September 2014. It showed 10 major peaks. Seven peak produced similar compound when compared with library data. The peak 1, 2 & 3 showed different possible compounds. Benzene group of the compound present in 1, 2, 5, 7, 8 and 10 peaks as possible compound present in the effluents which was collected from site 3 (Table 4.6.6). The possible compounds were Bicyclo[4.2.0]octa-1,3,5-triene; Styrene; Butanedioic acid, phenyl; 1,3,7-Octatrien-5-ynе; Benzeneethanamine, N-[(4-hydroxy)hydrocinnamoyl]-; Benzene, 1,1’-(1,2-cyclobutanediyl)bis-, cis-; Benzene, cyclobutyl-; Benzene, 4-azido-1-methyl-2-nitro; 3-(3-Pyridyl)-5-phenylisoxazoline; Naphthalene, 1,2,3,4-tetrahydro-2-phenyl; Benzene, 1,1’-[1-(2,2-dimethyl-3-butanyl)-1,3-propanediyl]bis-; Benzene, 1,1’-(3-methyl-1-propene-1,3-diy)bis; 2-Ethyl-5-methyl-3,3-diphenylpyrrolidine; 1-Propene, 2-(2-methylphenyl)-1-phenyl, (Z); Benzene, 1,1’-(1-butenylidene)bis; N-Benzyl-1H-benzimidazole; Benzene, 1,1’-(1,2-dimethyl-1,2-ethenediy)bis-, (Z); Benzene, 1,1’-(1,2-dimethyl-1,2-ethenediy)bis-, (E); Benzene, 1,1’-(1,2-diisocynano-1,2-dimethyl-1,2-ethanediyl)bis; N-Benzyl-N-(3-phenylprop-2-en-1-yl)tosylamide; 1-Propene, 2-(3-methylphenyl)-1-phenyl-, (Z); 3-(Benzythio)acrylic acid, methyl ester; Benzyl-N-(1-benzyl-2-hydroxyethyl)-N-methylcarbamat; Benzenemethanamine, 2-(1-methyllethyl)-N_-diphenyl; 1-Butanamine, 4-(phenylmethoxy)-3-[(phenylmethoxy)methyl]; 6-Phenyl-n-hexanol; 2,5,6-Triphenyl-5,6-dihydro-4H-1,3-oxazine; Pentanoic acid, 2-phenylethyl ester; 2-Phenethyl-__-phenylpropionate; Cyclobutane, 1,3-diphenyl-, trans-; Naphthalene, 1,2,3,4-tetrahydro-2-phenyl; 2-Methylbenzyl benzoate; 2,5,6-Triphenyl-5,6-dihydro-4H-1,3-oxazine; Pentanoic acid, 2-phenylethyl ester; 2-Phenethyl-__-phenylpropionate; benzene, 1,1’,1"-[5-methyl-1-pentene-1,3,5-triy]tris-; 1,2-Diphenyl-1-isocyanooethane; 1-benzylindole; Dibenzyl ketoxime; 4-[Benzylamino]benzo-1,2,3-triazine; Benzonitrile, m-phenyl; Benzenemethanamine, N-(phenylmethylenec); Dibenzylamine, N-nitro-; 1-Propene, 3-(2-cyclopentenyl)-2-methyl-1,1-diphenyl-; (2,3-Diphenylcyclopropyl)methyl phenyl sulfoxide, trans; Thiocarbacim acid, N,N-dimethyl, S-1,3-diphenyl-2-butanyl ester;
Cyclopentene-1-carboxylic acid, 4-[2-(diphenylmethyl)-2-propen-1-yl]-, methyl ester; Methadone N-oxide; H-Indole, 5-methyl-2-phenyl-; 1H-Indole, 2-methyl-3-phenyl-; Benzenamine, N-[(2-(1-methylethyl)phenyl)phenylmethylene]-; 1-benzyllindole; 2-Butanol, 1,2-diphenyl-4-(methylamino)-3-methyl-, propionate; 4-Phenyl-3,4-dihydroisoquinoline; Benzenamine, N-[(2-(1-methylethyl)phenyl)phenylmethylene]-; 5H-dibenzo[a,d]cyclohepten-5-amine; (3H)Pyrazole, 3,5-diphenyl-3-methyl; benzene, 1,1',1"-[5-methyl-1-pentene-1,3,5-triy]tris-; (2,3-Diphenylcyclopropyl)methyl phenyl sulfoxide, trans; 1-Propene, 3-(2-cyclopentenyl)-2-methyl-1,1-diphenyl-; Thiocarbamic acid, N,N-dimethyl, S-1,3-diphenyl-2-butenyl ester; Cyclopentene-1-carboxylic acid, 4-[2-(diphenylmethyl)-2-propen-1-yl]-, methyl ester; Methadone N-oxide; 4-Phenyl-3,4-dihydroisoquinoline; Benzenamine, N-[(2-(1-methylethyl)phenyl)phenylmethylene]-; 5H-dibenzo[a,d]cyclohepten-5-amine; (3H)Pyrazole, 3,5-diphenyl-3-methyl; benzene, 1,1',1"-[5-methyl-1-pentene-1,3,5-triy]tris-; Methadone N-oxide; benzene, 1,1',1"-[5-methyl-1-pentene-1,3,5-triy]tris-; 1-Propene, 3-(2-cyclopentenyl)-2-methyl-1,1-diphenyl-; Thiocarbamic acid, N,N-dimethyl, S-1,3-diphenyl-2-butenyl ester; 4-Acetamido-N,N-dibenzyl-3-nitrobenzamide; (2,3-Diphenylcyclopropyl)methyl phenyl sulfoxide, trans-; tripyrido[2,3-b:2',3'-f:2",3"-j][1,5,9]triazaclododecine; 1,3,5,7,9,11,13,15,17,19,21,23-Cycloctetrasadodecaene and cyclopentanone, 2,5-bis[3-phenyl-2-propen-1-ylidene]-.
January 2015: Site 1

Figure 4.6.7 showed GC-MS analysis of effluent collected from site 1 on January 2015. Totally 52 peaks were presented in chromatogram. Among 14 of 52 peaks were similar to library data. Similar single compound was predicted on peak 2 (11.56 min.) and 24 (16.17 min.) for Decane and 1-Nonene, 4, 6, 8-trimethyl, respectively. Other predicted compounds were Tributylamine; Tetrabutylammonium cyanide; Tetra-N-butylammonium chloride; Tetrabutylammonium hydrogen sulfate; Decane; Benzene, 1,3-bis(1,1-dimethylethyl); Benzene, 1,5-dimethyl-2,4-bis(1-methylethyl); Benzo[c]furanone, 3,3,4,7-tetramethyl; Phenol, 2-(1,1-dimethyl-2-propenyl)-3,6-dimethyl; Undecane, 2-methyl; Pentadecane; Dodecanes, 2,6,10-trimethyl; Eicosane; Tridecane, 2-methyl; Decane, 5-ethyl-5-methyl; 1-Nonene, 4,6,8-trimethyl; 1-Nonadecane; Octadecyl trifluoroacetate; 1-Decanols, 2-hexyl; Trifluoroacetoxy hexadecane; 1-Tetracosene; 1-Dodecanol, 2-hexyl; 1-Dodecanol, 2-methyl-, (S); 5-Eicosene, (E); Tetradecane; Undecane, 4,7-dimethyl; Dodecanes, 4,6-dimethyl; Dodecanes, 2,5-dimethyl; Dodecyl octyl ether; Oxalic acid, 6-ethyloct-3-yl ethyl ester; Oxalic acid, 6-ethyloct-3-yl isohexyl ester; Phenol, 2,5-bis(1,1-dimethylethyl): Phenol, 3,5-bis(1,1-dimethylethyl): 1-Nonene, 4,6,8-trimethyl; Hexadecane; Dodecanes, 2,7,10-trimethyl; Dodecanes, 4,6-dimethyl; Nonane, 3-methyl-5-propyl; Dibutyl phthalate; 1,2-Benzenedicarboxylic acid, butyl 2-methylpropyl ester; Phthalic acid, isobutyl 2-methylpent-3-yl ester; Phthalic acid, butyl 4-octyl ester; Diisoocyt phthalate; Phthalic acid, 5-methylhex-2-yl tridecyl ester; 1,2-Benzenedicarboxylic acid, mono(1-methylheptyl) ester, (±); Phthalic acid, di(2,4,4-trimethylpentyl) ester; Diisoocyt phthalate; Phthalic acid, di(6-methylhept-2-yl) ester; (2,3-Diphenylcyclopropyl)methyl phenyl sulfoxide, trans and Thiocarbamic acid, N,N-dimethyl, S-1,3-diphenyl-2-butenyl ester (Table 4.6.7).
January 2015: Site 2

In the present study, I have analysed effluent collected from site on January 2015. The analysed report showed 6 major peaks (Figure 4.6.8), all of them produced similar possible compound during library comparison. Table 4.6.8 shows possible compound present in the treated effluent. The first peak exhibited 5 possible compounds, Anthranilic acid, 2-methybutyl ester; Anthranilic acid, 3-methylbutyl ester; Benzoic acid, 2-amino-, pentyl ester; Methyl anthranilate; 4-Aminobenzoic acid. The possible compounds N-Phthaloyl-N'-phenylurea; 1H-Pyrrole-3,4-dicarbonitrile, 2,5-dihydro-2,5-dioxo; Hydrazinecarboxamide, 2-(phenylmethylene); Dibutyl phthalate; Phthalic acid, butyl non-5-yn-3-yl ester; Di-sec-butyl phthalate; 1,2-Benzenedicarboxylic acid, butyl 2-methylpropyl ester; 1,2-Benzenedicarboxylic acid, bis(2-methylpropyl) ester were present in peaks 2 and 3. Many different compound were detected as possible compound such as 1H-Isoindole-1,3(2H)-dione, 2-phenyl; N-(2-Carboxyphenyl)phthalimide; N-(2-Carboxyphenyl)phthalimide; Hydrazinecarbothioamide, 2-(phenylmethylene); 1-Cyclohexanone, 2-(2,4,5-trimethoxyphenyl); 3-(4-Acetyl-phenylimino)-1,3-dihydro-indol-2-one and 1H-Perimidine-6-carboxaldehyde, 2-trifluoromethyl in peaks 4, 5 and 6.
January 2015: Site 3

Figure 4.6.9 showed chromatogram (GC-MS) of effluent collected from site 3 on January 2015. All the major peaks exhibited possible compounds. The some of the assumed compounds were Aniline; Pyridine, 2-methyl; Phenol; Carbamic acid, phenyl ester; 2-Vinylfuran; Acetic acid, phenyl ester; p-Aminotoluene; Benzenamine, 3-methyl; Acetamide, N-(4-methylphenyl); 4-p-Tolylamino-oxazolidin-2-one; Urea, (4-methylphenyl); Acetamide, N-(3-methylphenyl); Benzenamine, 2,5-dichloro; Acetamide, N-(2,4-dichlorophenyl); Urea, (3,4-dichlorophenyl); Benzenesulfonamide, N-[(phenylamino)thioxomethyl]; Furazan, 3-methyl-4-penylsulfonynamino; Bicyclo[2.2.1]heptane-1-carbonyl chloride, 2-exo-chloro-; 5-Ethyl-5-cyclohepta-1,3-dienyl-hexahydropyrimidin-2,4,6-trione; 3H-Pyrazol-3-one, 1,2-dihydro-2,5-dimethyl-1-phenyl; 1,4-Naphthoquinone, 2,3-dihydro-5,8-dimethyl; 6-Hydroxy-2-phenyl-3(2H)-pyridazinone; 3H-pyrazol-3-one, 5-ethyl-2,4-dihydro-2-phenyl; 11-Isopropyldenetricyclo[4.3.1.1(2,5)]undec-3-en-10-one; benzenesulfonamide, N-(4,5-dihydro-3-methyl-5-oxo-1-phenyl-1H-pyrazol-4-yl)-N-methyl; 4a,5-Dimethyl-3-(prop-1-en-2-yl)-1,2,3,4,4a,5,6,7-octahydronaphthalen-1-ol; 1,2,4-Triazino[5,6-b]indole-3-thiol, 5-(2-phenylethyl); Silphiperfola-4,7(14)-diene; 1,10-Dimethylpentacyclo[5.4.0.0(2,6).0(3,10).0(5,9)]undecane-8,11-dione; 3H-Pyrazol-3-one, 2,4-dihydro-5-methyl-2-(4-methylphenyl); Pentacyclo[7.3.1.1(4,12).0(2,7).0(6,11)]tetracane(diamantan); 1,3-Dimethyl-4-cyclohexylbenzene; Cyclopentane-3'-spirotricyclo[3.1.0.0(2,4)]hexane-6'-spirocyclopentane; Benzenesulfonop-toluidide; 3'-Methylbenzenesulfonanilide; Benzenesulfonamide, N-methyl-N-phenyl; benzenesulfonamide, N-methyl-N-(4-nitrophenyl); 4-(1,1,2,3,3,3-Hexafluoro-propylsulfanyl)-benzene-1,3-diol; 1-(8-Coumarinyl)-3-methyl-3-(2-methylphenyl)guanidine; N-Fluorobenzenesufonimide; Benzenesulfonamide, N-[(phenylamino)thioxomethyl] and Pyridine, 1,2-dihydro-1-diphenylboryl-5-chloro-2-(2-pyridylimino) (Table 4.6.9) present in the sample collected from site 3 of January 2015.
In the present study, some of the possible compounds were found in industrial effluent and detected by GC-MS. Similarly, Ladwani et al., (2016) identified Naphthalene, Anthracene with some other compounds like phenol by GC-MS analysis of effluent water collected from Ankleshwar, Gujarat, India. US-EPA and European Commission stated that aromatic hydrocarbanes pollute the water and their environments. Many chemical such as aromatic hydrocarbons, phenols, nitroaromatics, and azo dyes present in industrial effluent in high concentration (Castillo-Carvajal et al., 2014). Euvrard et al., (2017) stated that industrial discharged water contained higher concentration of polycyclic aromatic hydrocarbons. Phenol and other phenolic compounds are common elements of many industrial effluents from oil refining, pesticides, pulp and paper manufacturing etc. (Hosseiny and Borghei, 2005).

There were some identical compounds presence in the samples collected from site 1 and 3 of May 2014. The compounds were Phenol, 2,4-dichloro- and Phenol, 2,4-dichloro-, acetate. There was only one similar compound, Hexadecane, observed in the sample collected from site 1 of May 2014 and January 2015. The maximum similarity of presence of compounds was observed in the samples collected from three different sites of September 2014. (2,3-Diphenylcyclopropyl)methyl phenyl sulfoxide, trans- and Thiocarbamic acid, N,N-dimethyl, S-1,3-diphenyl-2-butenyl ester were observed in the samples collected from site 1, 2 and 3 of September 2014 and site 1 of January 2015. Two compounds, Dibutyl phthalate and 1,2-Benzenedicarboxylic acid, butyl 2-methylpropyl ester were present in the samples collected from site 1 and 2 of January 2015. Below table shows the presence of similar compounds in the samples collected from different sites of May 2014, September 2014 and January 2015.
Presence of possible similar compounds at different sites from May 2014, September 2014 and January 2015

<table>
<thead>
<tr>
<th>Name of the possible compounds</th>
<th>May 2014</th>
<th>September 2014</th>
<th>January 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Site 1</td>
<td>Site 2</td>
<td>Site 3</td>
</tr>
<tr>
<td>Phenol, 2,4-dichloro-</td>
<td>✓</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Phenol, 2,4-dichloro- acetate</td>
<td>✓</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Hexadecane</td>
<td>✓</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Bicyclo[4.2.0]octa-1,3,5-triene</td>
<td>-</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td>Styrene</td>
<td>-</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td>Benzene, 1,1’-[1-(2,2- dimethyl-3-butenyl)-1,3- propanediyl]bis-</td>
<td>-</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td>Benzene, 1,1’-(3-methyl-1- propene-1,3-diyl)bis-</td>
<td>-</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td>Benzene, 1,1’-(1,2- cyclobutanediyl)bis-, trans-</td>
<td>-</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td>Benzene, 4-azido-1-methyl- 2-nitro-</td>
<td>-</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td>2-Methylbenzyl benzoate</td>
<td>-</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td>Benzeneacetic acid, 2- phenylethyl ester</td>
<td>-</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td>Cyclopentene-1-carboxylic acid, 4-[2-(diphenylmethyl)- 2-propen-1-yl]-, methyl ester</td>
<td>-</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td>1-benzyllindole</td>
<td>-</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td>1,2-Diphenyl-1- isocyanate</td>
<td>-</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td>(2,3- Diphenylcyclopropyl)methyl phenyl sulfoxide, trans-</td>
<td>-</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td>Thiocarbamic acid, N,N- dimethyl, S-1,3-diphenyl-2- butenyl ester</td>
<td>-</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td>Methadone N-oxide</td>
<td>-</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td>Naphthalene, 1,2,3,4- tetrahydro-1-phenyl-</td>
<td>-</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td>1-Propene, 3-(2- cyclopentenyl)-2-methyl- 1,1-diphenyl-</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>1,11-Diphenyl-1,3,5,7,9- undecapentaene</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>2-(n-Propyl)oxybenzylidene acetophenone</td>
<td>-</td>
<td>-</td>
<td>✓</td>
</tr>
</tbody>
</table>

**Key:** - = Not applicable and ✓ = Presence of compound
Presence of possible similar compounds at different sites from May 2014, September 2014 and January 2015 (Continued)

<table>
<thead>
<tr>
<th>Name of the possible compounds</th>
<th>May 2014</th>
<th>September 2014</th>
<th>January 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Site 1</td>
<td>Site 2</td>
<td>Site 3</td>
</tr>
<tr>
<td>Benzenamine, N-[(2- (1-methylethyl)phenyl)phenylmethylene]-</td>
<td>-</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td>4-Phenyl-3,4-dihydroisoquinoline</td>
<td>-</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td>benzene, 1,1',1''-[5-methyl-1-pentene-1,3,5-triyl]tris-</td>
<td>-</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td>Butanedioic acid, phenyl</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Naphthalene, 1,2,3,4-tetrahydro-2-phenyl</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2-Ethyl-5-methyl-3,3-diphenylpyrrolidine</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1-Propene, 2-(2-methylphenyl)-1-phenyl-, (Z)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>N-Benzyl-1H-benzimidazole</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Benzene, 1,1'-[1,2-dioscyno-1,2-dimethyl-1,2-ethanediyl]bis</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3-(Benzylthio)acrylic acid, methyl ester</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Benzyl-N-(1-benzyl-2-hydroxyethyl)-N-methylcarbamat</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>Benzene, 1,1'-[1,2-cyclobutanediyl]bis-, cis-</td>
<td>-</td>
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</tr>
<tr>
<td>Butanedioic acid, phenyl</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4-[Benzylamino]benzo-1,2,3-triazine</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Benzonitrile, m-phenethyl</td>
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<td>-</td>
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</tr>
<tr>
<td>N-Benzyl-N-(3-phenylprop-2-en-1-yl)-tosylamide</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3-(3-Pyridyl)-5-phenyllisoxazoline</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Benzene, 1,1'-[1-butenyldiene]bis</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Benzene, 1,1'-[1,2-dimethyl-1,2-ethenediy]bis-, (Z)</td>
<td>-</td>
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<td>-</td>
</tr>
<tr>
<td>Benzene, 1,1'-(1,2-dimethyl-1,2-ethenediy)bis-, (E)</td>
<td>-</td>
<td>-</td>
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</tr>
</tbody>
</table>

Key: - = Not applicable and ✓ = Presence of compound
Presence of possible similar compounds at different sites from May 2014, September 2014 and January 2015 (Continued)

<table>
<thead>
<tr>
<th>Name of the possible compounds</th>
<th>May 2014</th>
<th>September 2014</th>
<th>January 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Site 1</td>
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<td>Benzenamine, N-[[2-</td>
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</tr>
<tr>
<td>1-methylethyl]phenyl[phenylmethylene]-</td>
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<td>✔</td>
</tr>
<tr>
<td>4-Phenyl-3,4-</td>
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<td></td>
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</tr>
<tr>
<td>dihydroisoquinoline</td>
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<td>Benzene, 1,1',1''-[5-</td>
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<td>methyl-1-pentene-1,3,5-triyl</td>
<td></td>
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<tr>
<td>Butanedioic acid, phenyl</td>
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<td>1-Propene, 2-(3-</td>
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<td>methylphenyl)-1-phenyl-, (Z)</td>
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<td>Benzenemethanamine, N-(phenylmethylene)</td>
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<tr>
<td>amine</td>
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</tr>
<tr>
<td>Dibutyl phthalate</td>
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<tr>
<td>1,2- Benzenedicarboxylic</td>
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</tr>
<tr>
<td>acid, butyl 2- methylpropyl ester</td>
<td></td>
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</tr>
</tbody>
</table>

Key: - = Not applicable and ✔ = Presence of compound
4.4 CONCLUSION

The analysis of presence of possible compounds by GC-MS in the industrial effluents discharged from various industrial branches and the distribution of the emitted pollutants in the Sachin industrial area have been done. Based on the analysis and comparison of the data obtained with the results allowed the determination of wastewater constituents. GC-MS spectral studies of nine samples of three selected sites of Sachin industrial area shows that the presence of various aromatic, aliphatic, heterocyclic, cyclic, aromatic cyclic and aliphatic cyclic compounds. Lack of knowledge on the ecotoxicological properties of many of these contaminants represents a major concern due to the uncertainty in possible effects they could cause on the aquatic environment and human health after their release to surface waters.

In conclusion, the comprehensive and detailed evaluation of the indicative compounds in the industrial effluents is a promising tool for the environmental assessment of industrial emissions, especially if accompanied with toxicological and ecotoxicological investigations of novel environmental contaminants. The approach applied on the regular basis will prove useful for the environmental monitoring measures and efficient identification of contamination sources. These organic pollutants can cause several diseases like hypoglycemia, skin irritation, headache, reproductive disorders and even cancer. Thus, the investigation clearly indicated that treatment of industrial wastewater should be practiced before throwing it out.

The result achieved in the present research using GC-MS study of industrial effluents confirm the presence of organic compounds in the industrial effluents. Many forms of organic compounds in wastewater are toxic to aquatic environment and humans. In the analysis, it is found the presence of alcohol, phenol and amine groups may be responsible for the color of the wastewater due to the complex nature of the wastewater. The contamination of combined multi-complex compounds in wastewater becomes very toxic. Efforts therefore have to be made either to control the wastewater quality or to provide some specific treatment employing advanced treatment methods/processes to improve the quality of treated wastewater.
### 4.6 TABLES AND FIGURES

#### Table 4.6.1 GC-MS Analysis of Industrial Effluent of May 2014: Site 1

<table>
<thead>
<tr>
<th>Peak</th>
<th>RT</th>
<th>Height</th>
<th>Area</th>
<th>% Area</th>
<th>Name of the possible compounds</th>
<th>Group</th>
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</thead>
<tbody>
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<td>1</td>
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<td>31222.3</td>
<td>97727</td>
<td>31.82</td>
<td>Phenol, 2,4-dichloro-</td>
<td>Aromatic</td>
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<tr>
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<td></td>
<td></td>
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<td>Phenol, 2,6-dichloro-</td>
<td></td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td>Phenol, 2,5-dichloro-</td>
<td></td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td>Phenol, 2,4-dichloro-, acetate</td>
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<td></td>
<td></td>
<td></td>
<td>2,6-Dichlorophenol, isopropyl ether</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Hydrazinecarboximidamide, 2-</td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
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<td>[2-(2,6-dichlorophenoxy)ethyl]-</td>
<td></td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td>2,3-Dichlorophenol, isopropyl ether</td>
<td></td>
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**Key:** RT = Retention Time
Figure 4.6.1 The GC-MS Chromatogram of Industrial Effluent of May 2014: Site 1

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**Key:** RT = Retention Time
### Table 4.6.2  GC-MS Analysis of Industrial Effluent of May 2014: Site 2  
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**Key:** RT = Retention Time
Figure 4.6.2  The GC-MS Chromatogram of Industrial Effluent of May 2014: Site 2

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**Key:** RT = Retention Time
Figure 4.6.3  The GC-MS Chromatogram of Industrial Effluent of May 2014: Site 3
### Table 4.6.4 GC-MS Analysis of Industrial Effluent of September 2014: Site 1

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**Key:** RT = Retention Time
### Table 4.6.4  GC-MS Analysis of Industrial Effluent of September 2014: Site 1 (Continued)

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**Key:** RT = Retention Time
Figure 4.6.4  The GC-MS chromatogram of Industrial Effluent of September 2014: Site 1

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Key: RT = Retention Time
Table 4.6.5  GC-MS Analysis of Industrial Effluent of September 2014: Site 2 (Continued)

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Key: RT = Retention Time
Figure 4.6.5  The GC-MS chromatogram of Industrial Effluent of September 2014: Site 2

![GC-MS Chromatogram](image)

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### Table 4.6.6  GC-MS Analysis of Industrial Effluent of September 2014: Site 3

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**Key:** RT = Retention Time
### Table 4.6.6 GC-MS Analysis of Industrial Effluent of September 2014: Site 3 (Continued)

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**Key:** RT = Retention Time
### Table 4.6.6  GC-MS Analysis of Industrial Effluent of September 2014: Site 3 (Continued)

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**Key:** RT = Retention Time
Figure 4.6.6 The GC-MS chromatogram of Industrial Effluent of September 2014: Site 3

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### Table 4.6.7 GC-MS analysis of Industrial Effluent of January 2015: Site 1

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**Key:** RT = Retention Time
Table 4.6.7  GC-MS analysis of Industrial Effluent of January 2015: Site 1 (Continued)

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Key: RT = Retention Time
Figure 4.6.7  The GC-MS chromatogram of Industrial Effluent of January 2015: Site 1

Integration Peak List

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Table 4.6.8 GC-MS Analysis of Industrial Effluent of January 2015: Site 2

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Key: RT = Retention Time
Figure 4.6.8  The GC-MS chromatogram of Industrial Effluent of January 2015: Site 2
### Table 4.6.9  GC-MS Analysis of Industrial Effluent of January 2015: Site 3

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<thead>
<tr>
<th>Peak</th>
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<th>Area</th>
<th>% Area</th>
<th>Name of the possible compounds</th>
<th>Group</th>
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<tr>
<td>1</td>
<td>8.06</td>
<td>4518055</td>
<td>7650054</td>
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<td>5237523</td>
<td>1.04</td>
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<td>p-Aminotoluene</td>
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<td>Benzenamine, 3-methyl</td>
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<tr>
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<td>Acetamide, N-(4-methylphenyl)</td>
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<td>Acetamide, N-(3-methylphenyl)</td>
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<tr>
<td>3</td>
<td>9.73</td>
<td>9694378</td>
<td>1.9E+07</td>
<td>3.76</td>
<td>Benzenamine, 2,5-dichloro</td>
<td>Aromatic</td>
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<td>Acetamide, N-(2,4-dichlorophenyl)</td>
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<td>Urea, (3,4-dichlorophenyl)</td>
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<tr>
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<td>4a,5-Dimethyl-3-(prop-1-en-2-yl)-1,2,3,4,5,6,7-octahydroporphthalen-1-ol</td>
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<td>1,2,4-Triazino[5,6-b]indole-3-thiol, 5-(2-phenylethyl)</td>
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</tbody>
</table>

**Key:** RT = Retention Time
Table 4.6.9  GC-MS Analysis of Industrial Effluent of January 2015: Site 3 (Continued)

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<th>Peak</th>
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<th>Group</th>
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Key: RT = Retention Time
Figure 4.6.9  The GC-MS chromatogram of Industrial Effluent of January 2015: Site 3

Integration Peak List

<table>
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<th>Area %</th>
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