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Microplastic Contamination: A Case Study in the Freshwater of Krishna River

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ABSTRACT

This case study investigates the microplastic content in the floating river water as well as the types of Microplastics (MPs)This current case study confirms the presence of MPs in fresh river water and makesa realization on the of MPs.In the river Krishna, three different pilgrim sites were selected and the plankton net method was used for sampling. All three site samples showed different types of MPs including polypropylenes (PP) isotactic C1-C40 at Jurala (site-I), Polyethylenes (PE) Chlorinated C1-C40 at Koilsagrar (site-II), and Polyoxymethylenes (POM) C1-C40. This approach could be relevant and implemented in future studies to provide an accurate overview of microplastic content in Krishna River water

Key words - Microplastics, Krishna River, Jurala, Polyoxymethylenes, Polyethylenes, Polypropylenes.

INTRODUCTION

Plastic, a petroleum-based material, has irrevocably altered the globe. Commercial plastic production began in the 1940s and 1950s (Hahladakis et al., 2018). Following then, because to the range of its benefits, plastic manufacturing exploded. Due to its long-lasting and low-cost character, plastic is widely employed in everyday life, as well as in scientific, technological, and industrial applications. To date, 8300 million metric tonnes of virgin plastic have been manufactured. By 2050, nearly 12000 million metric tonnes of plastic garbage will be found in natural areas and landfills if current trends continue. (Geyer and colleagues, 2017). Polyethyleneimine, High-density polyethylene, Low-density polyethylene, Polyvinyl chloride, Polypropylene, Polyamide, Polystyrene, and several miscellaneous plastics are examples of plastic polymers. Plastic polymers are generally safe;however, they aren't used in their purest form.

To improve the material's qualities, polymers are mixed with monomeric elements or additions (Deanin, 1975). Protecting plastic against degradation and ageing during processing or in use (antioxidants, light stabilizers, or heat stabilizers), facilitating processing (lubricants, mold-release agents, or blowing agents), and imparting desirable properties to plastics are the three kinds of additives. (Flame retardants, fillers, dyes, pigments, antistatic agents, nucleating agents, optical brighteners, impact modifiers, and plasticizers) (Pelzi et al., 2018). Protecting plastic against degradation and ageing during processing or in use (antioxidants, light stabilizers, or heat stabilizers), facilitating processing (lubricants, mold-release agents, or blowing agents), and imparting desirable properties to plastics are the three kinds of additives. Plastic pollution is widely recognized as a severe environmental problem because of its rapid decomposition (Wang et al., 2016). Plastics are more prone to fragmentation than deterioration, resulting in the material's size being reduced. When the plastic particles reach up to the size of 25mm), mesoplastic (5-25mm), large microplastic (1-5mm), small microplastic (20µm1mm), and nano plastic (1-1000nm) (Gigault et al., 2018). There are two forms of microplastic: primary and secondary.

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Pellets and microbeads are examples of primary microplastics that are purposefully made. Secondary microplastics are created as a result of the fragmentation and degradation of big plastics (Wen et al., 2018). Extreme weathering and exposure to increased UV levels make secondary plastic more prone to fragmentation (Horton et al., 2017). Microplastics are a particular source of worry since their capacity to bioaccumulate increases as their size decreases (Wagner et al., 2014). Microplastics' small size makes them vulnerable to ingestion by organisms and the organic pollutants they carry. These particles can be consumed by a wide range of creatures, including plankton, fish, birds, and even mammals, and accumulate throughout the food web (Batel et al., 2016). The majority of scientific research on microplastic has been conducted in the marine ecosystem. However, there has been new research on freshwater, terrestrial, and human health issues (Pico et al., 2018, Blasing et al., 2017, Rist et al., 2018). Due to the significant adsorption capacity of microplastics, these particles can carry or accumulate additional dangerous chemicals utilized as additives in their manufacture, easing the entry of these chemicals into various organisms. Microplastics in the environment are a source of tremendous worry due to their interaction with environmental pollutants and subsequent exposure of these chemicals to organisms. As a result, when microplastic is swallowed, it causes both physical and chemical harm to animals. The Krishna River is the fourth-biggest river in terms of water inflows and river basin area in India, after the Ganga,Godavari, andBrahmaputra. The river is almost 1,288 kilometers (800miles) long. The river is also called Krishnaveni. It is one of the major sources of irrigation forMaharashtra,Karnataka, and Telangana. Mahbubnagar district is spread over an area of 2,737.00 square kilometers (1,056.76 sq mi).The Krishna River flowsthrough the district, aswell as the Tungabhadra. They merge at Sangameswaram. The Krishna River has been identified as a major source of microplastic pollution. The main sources of microplastic pollution are untreated sewage water, religious offerings, and cultural festivities. From the surrounding settlements, sewage water enters the river. The largest source of microplastic load in the Krishna River is various human actions such as waste material disposal. These materials have been reduced to micro-particles. Because the mechanism of metal adsorption on microplastic is so variable and complex, it is still mostly unknown (Brennecke et al., 2016). As a result, efforts should be made to comprehend the complex mixture of pollutants connected with this item. The research on interactions between microplastic and other contaminants in freshwater will be crucial in defining microplastic's ecological implications as a multiple stressors. The Krishna River in Mahabubnagar District is well-known for its diverse fish population, as well as its abundance and distribution. 109 species offishs have been recorded from the Krishna River, based on percentage composition and species richness, order Cypriniformes was dominant (61 species) followed by Siluriformes (26 species), Perciformes (13 species), Synbranchiformes (4 species), Beloniformes (3 species), Osteoglossiformes and Anguilliformes (1 species each). Cyprinus carpio is one of the most ecologically destructive freshwater fish species, and it is one of the world's eight most invasive fish taxa. It possesses a number of features that contribute to its

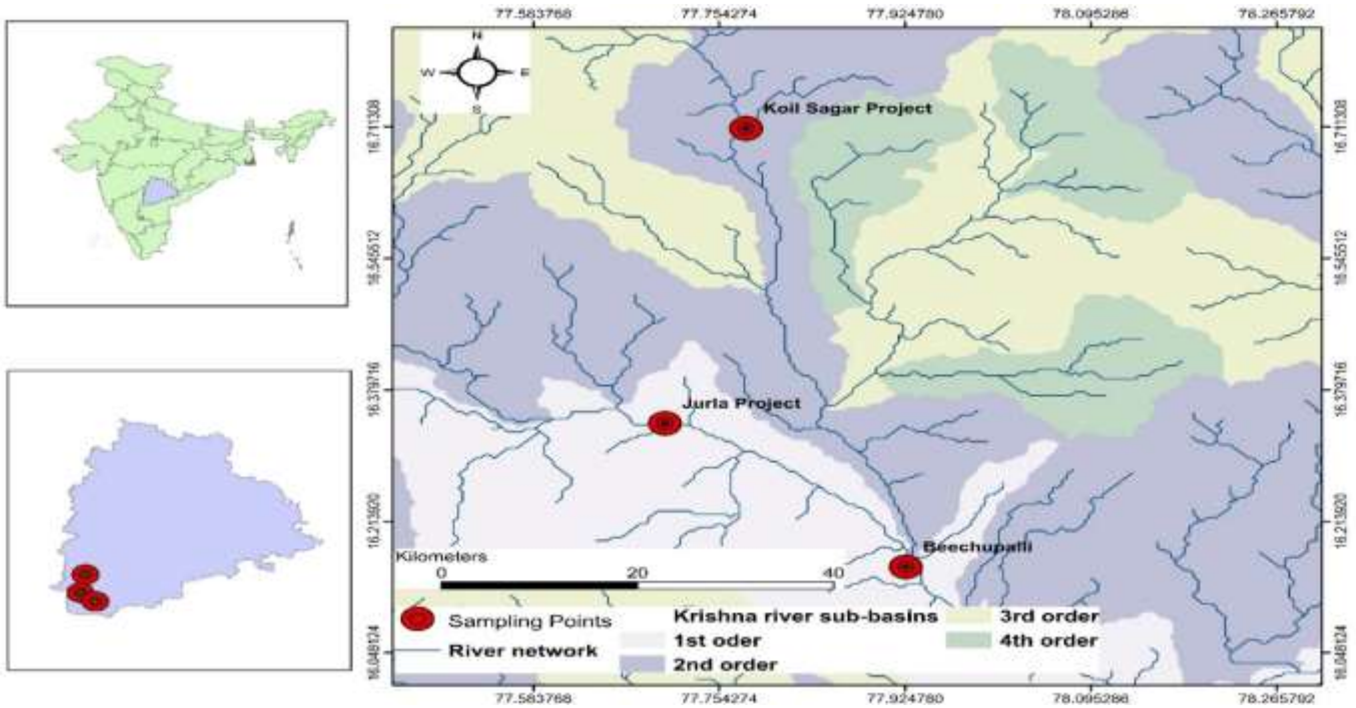


Figure 1: Location of sampling points in Krishna river sub-basin

invasive nature, including as a wide range of environmental tolerance and early sexual maturity.

MATERIAL AND METHODS

Methodology from **(Nuelle et al., 2014 and Hendrickson et al., 2018)** was followed. Samples are collected at 11:51 am, in month of January. A sample was taken at a distance of 200 meters from the station bank. For sampling 50µm mesh sized student plankton net was used to collect surface water from the different stations of Krishna River in Telangana. The plankton net was washed with distilled water in a glass trough. The wash-off from the net was filtered in the laboratory using 40, 100, and 250µm sieves to separate microplastics on the basis of their size. An oxidation procedure was performed to degrade organic matter using hydrogen peroxide (30%). The samples are filtered with Whatman filter paper and then wash off the filter paper with distilled water. 40 ml of potassium iodide is added to each 10 ml sample for density separation. Density separation is performed to isolate lighter plastic particles. Samples are centrifuged at 3200 rpm. The supernatant is collected in a petri dish. Particles are subjected to visual inspection followed by a hot needle test, ATR-FTIR, and Thermal GC-MS techniques for identification and chemical analysis.

Determination of micro plastic particles collected from the water samples of Jurala project, Koilsagar, Beechupally:

Methodology from **(Nuelle et al., 2014 and Hendrickson et al., 2018)** was followed. Samples are collected at 11:51 am, in the month of January. A sample was taken at a distance of 200 meter from the station bank. For sampling 50µm mesh sized student plankton net was used to collect surface water from different station of Krishna River in Telangana. The plankton net was washed with distilled water in glass trough. The wash off from the net was filtered in laboratory using 40, 100 and 250µm sieves to separate microplastics on the basis of their size. Oxidation procedure was performed to degrade organic matter using hydrogen peroxide (30%). The samples are filtered with Whatman filter paper then wash of the filter paper with distilled water. 40 ml of potassium iodide is added to each 10 ml sample for density separation. Density separation is performed to isolate lighter plastic particles. Samples are centrifuged at 3200 rpm. The supernatant is collected in petri dish. Particles are subjected to visual inspection followed by hot needle test, ATR-FTIR, and Thermal GC-MS techniques for identification and chemical analysis.

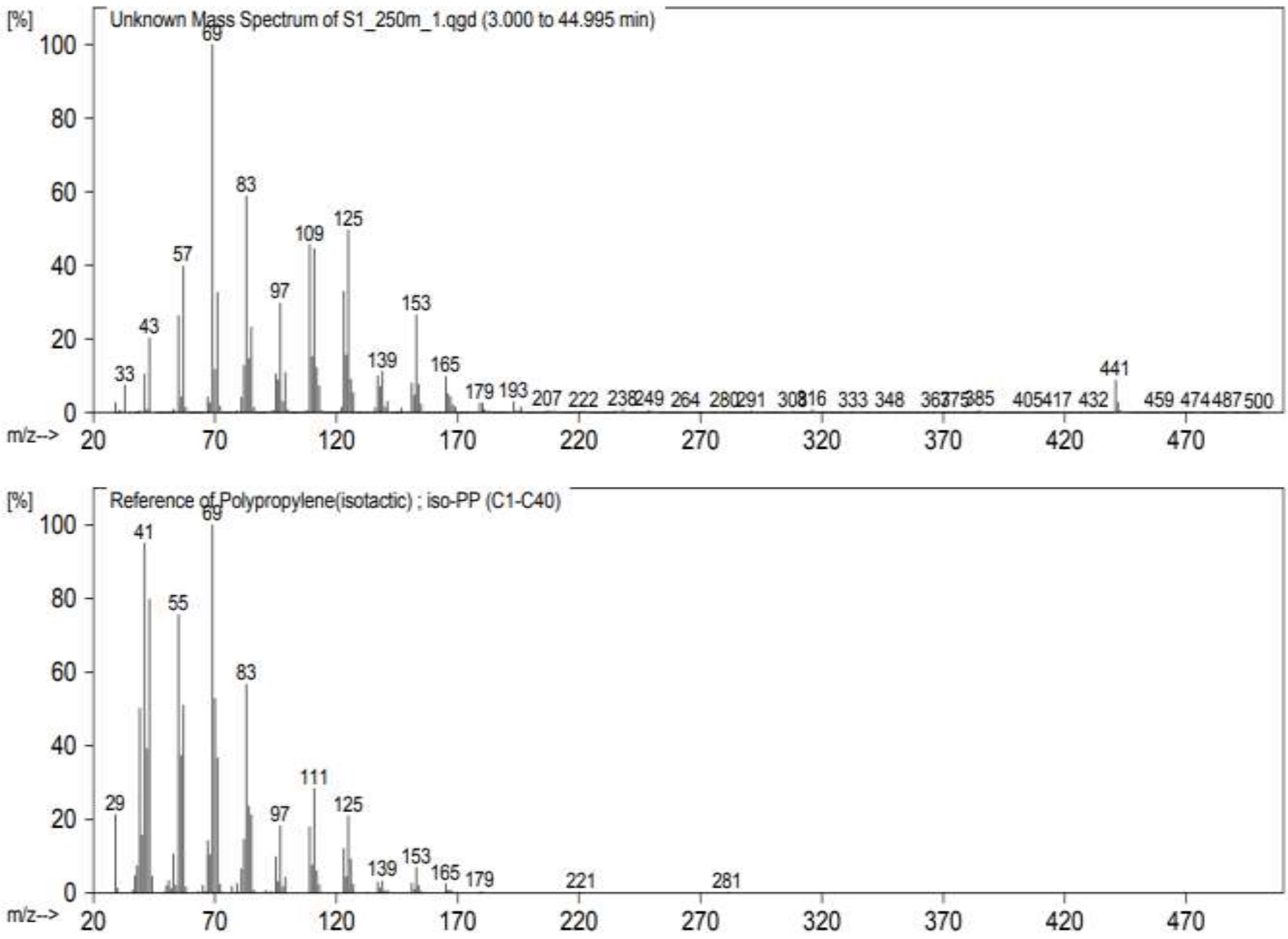
Study Area

Jurala project: The Priyadarshini Jurala Project or Jurala Project is situated about 10 km from Kuravapur, Mahbubnagar district, Telangana shown in **Figure 1**, India.It is constructed on the Krishna river. The KurvapurKshetra River is merging with water of the Jurala Project. The Jurala has a full reservoir level of 1045 ft and has a full capacity of 11.94 TMC. It is located at latitude 16°20'15" N longitude 77°42'15" E. The project has an estimated capacity of 9.74 TMC. The place Jurala is located at a distance of about 60 kilometers away from Mahabubnagar town in between the Atmakur and Gadwal towns. The power projects constructed and maintained by Telangana State Power Generation Corporation Ltd. Purpose of Dam Multi-Purpose, Irrigation, Hydroelectric. Jurala water is used for drinking in 6 districts. This project water is useful to 69,117 acres of land.

Koilsagar: Koilsagar Dam is located at Koilsagar Village of Deverakadra Mandalin Mahabubnagar district. Koilsagar dam is 25 km from Mahabubnager district. Koilsagar is located at a 57.1km distance from Jurala (**Figure 1**). It is located at latitude 16°42'33.73"N and

Table 1. Data for analysing the water quality

Winter season parameters	Desirable Limits	S 1 (11-01-2022)	S2 (12-01-2022)	S3 (13-01-2022)
Air Temperature ^{0}C	15 – 30	20 ± 0	20 ± 0	20.1 ± 0.1
Water Temperature ^{0}C	15 – 30	19.06 ± 0.057	18.4 ± 0.05	18.3±0.57
pH	6.5 – 8.5	7.7 ± 0.05	6.8 ± 0.057	8.13±0.057
Hardness of water(mg/l)	200 – 600 mg/l	180.6 ± 1.154	177.3 ± 0.57	185.3±0,57
TDS (mg/l)	500 – 1000 mg/l	489 ± 1	485.6 ± 0.5	491.6±0.55
DO (mg/l)	6.5 – 8.5	7.7 ± 0.05	6.8 ± 0.057	7.8±0.057
Alkalinity(mg/l)	200 – 600 mg/l	228.3 ± 0.57	225.3 ± 0.57	236.3±0.57



	Polymer/Additive
1	Carnauba wax (C1-C40)
2	Polypropylene(isotactic) ; iso-PP (C1-C40)
3	Polypropylene(isotactic) ; iso-PP (C1-C40)
4	Non-woven fabrics (Polyethylene, Tyvek(R) #1073D) (C1-C40)
5	Non-woven fabrics (Polyethylene, Tyvek(R) #1073D) (C1-C40)
6	Polypropylene (random copolymer) ; PP (C1-C40)
7	Polypropylene (random copolymer) ; PP (C1-C40)
8	Higher methacrylate copolymer (C1-C40)
9	Bag (Polyethylene, for business use) (C1-C40)
10	Linear low density polyethylene ; L-LDPE (C1-C40)
11	Bag (Polyethylene, for business use) (C1-C40)
12	Higher methacrylate copolymer (C1-C20)
13	Higher methacrylate copolymer (C1-C20)
14	Higher methacrylate copolymer (C1-C40)

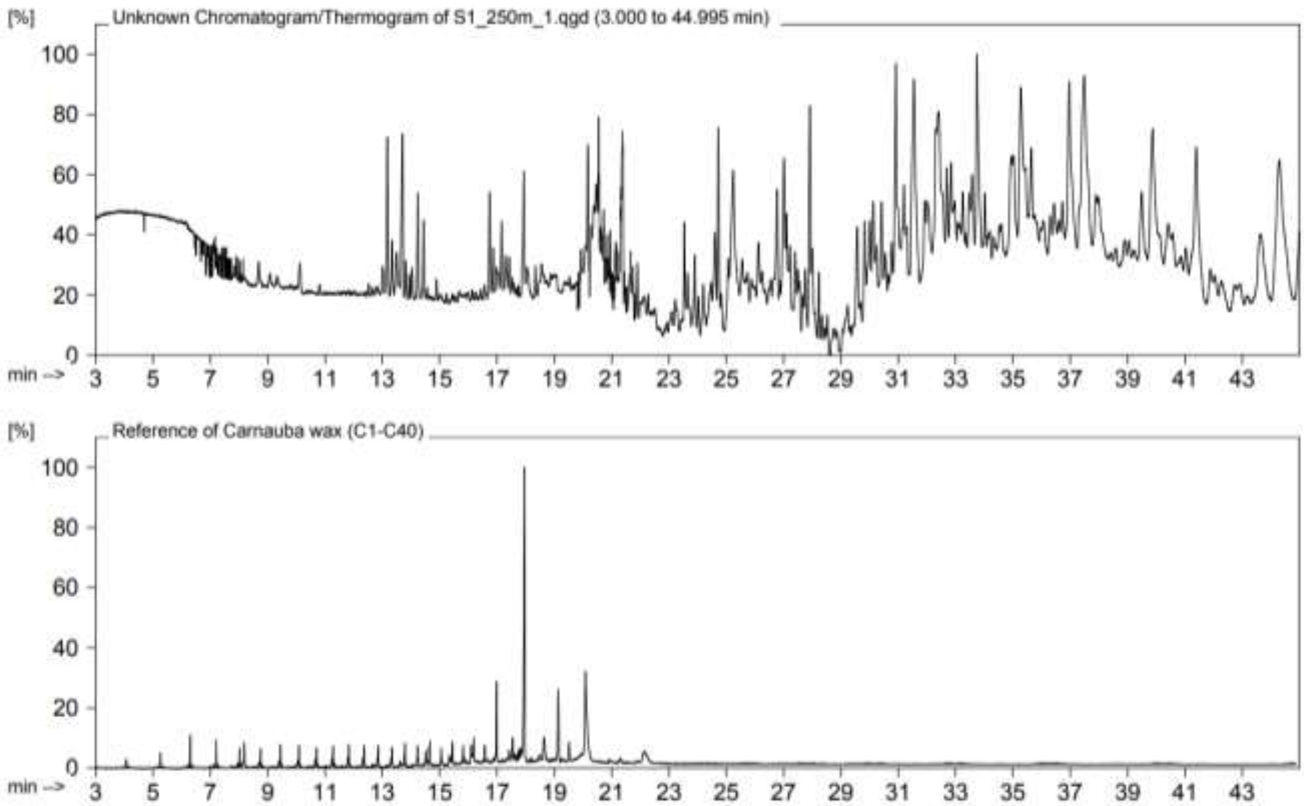
Figure-2. GCMS Spectra of the site-1 sample

longitude 77°46'44.08"E. This medium reservoir with live water storage capacity of 60 million cubic meters, was constructed on the ped davagu tributary of Krishna River.The Kolisagar Dam is a medium-sized irrigation project that was constructed in the period of Nizams during1945-48. This dam water is used to 12000 acres of land.

Beechupally: Beechupally is in Jogulamba Gadwal district, Telangana. Beechupally is 37.9km from the Jurala project. Beechupally water is used in 66 hectares of field. It is located at latitude 16^{o}09'32.7"N and longitude 77^{o}55'43.2"E (**Figure 1**).

RESULTS AND DISCUSSION

Water quality of the samples was analyzed by the Using a TDS metre (DREL 2000 HACH, INDIA), pH Meter (Auto), and direct titration of water samples.



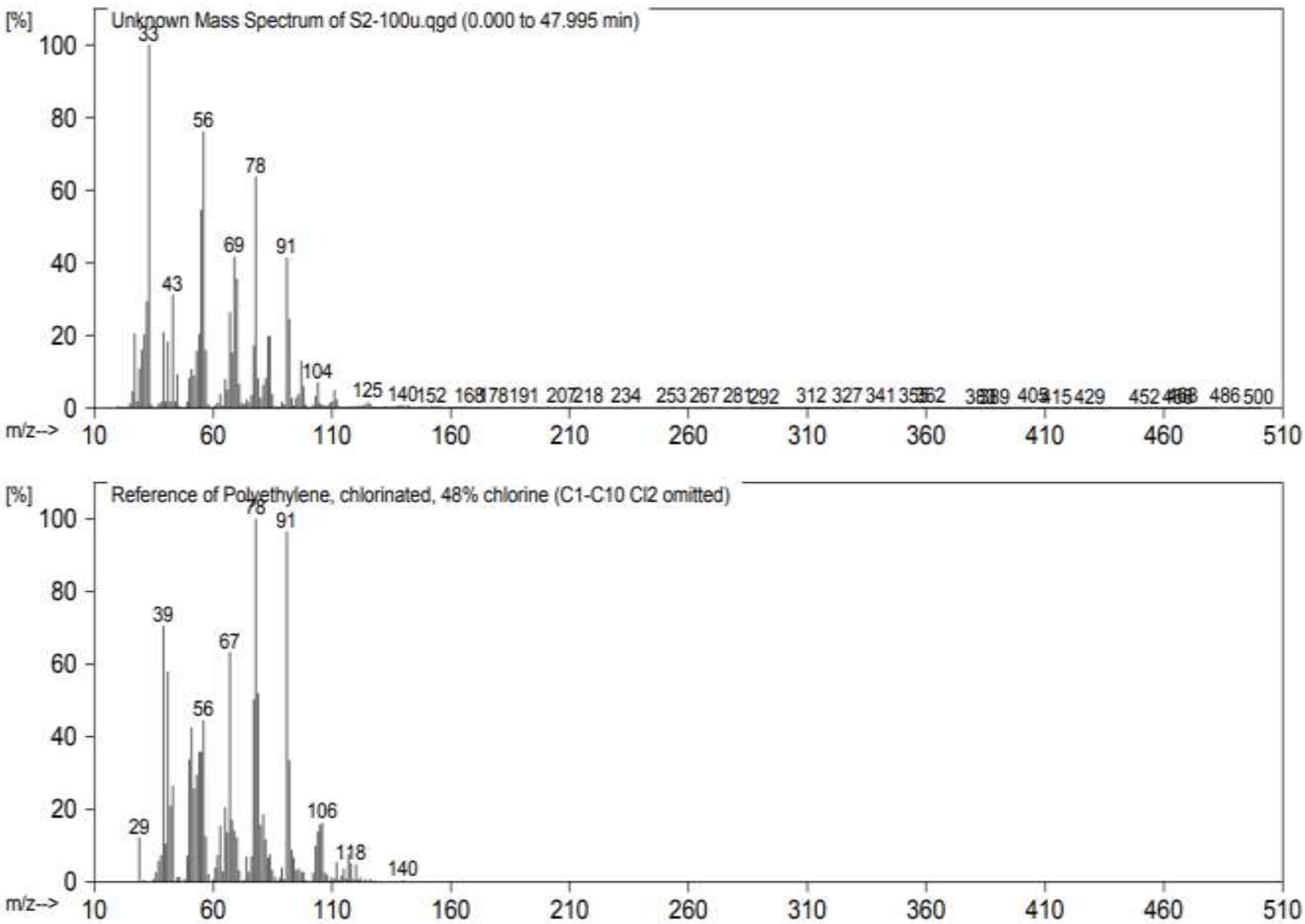
	Polymer/Additive	EntryID	Qual[%]
1	Carnauba wax (C1-C40)	FLK-853	54
2	Polypropylene(isotactic) ; iso-PP (C1-C40)	FLG-051	52
3	Polypropylene(isotactic) ; iso-PP (C1-C40)	FLG-051	52
4	Non-woven fabrics (Polyethylene, Tyvek(R) #1073D) (C1-C40)	FLE-0310	50
5	Non-woven fabrics (Polyethylene, Tyvek(R) #1073D) (C1-C40)	FLE-0310	50
6	Polypropylene (random copolymer) ; PP (C1-C40)	FLY-053	49
7	Polypropylene (random copolymer) ; PP (C1-C40)	FLY-053	49
8	Higher methacrylate copolymer (C1-C40)	FLT-044	48
9	Bag (Polyethylene, for business use) (C1-C40)	FLE-0411	48
10	Linear low density polyethylene ; L-LDPE (C1-C40)	FLY-007	48
11	Bag (Polyethylene, for business use) (C1-C40)	FLE-0411	48
12	Higher methacrylate copolymer (C1-C20)	FLT-044	48
13	Higher methacrylate copolymer (C1-C20)	FLT-044	48
14	Higher methacrylate copolymer (C1-C40)	FLT-044	48

Figure-3. FTIR of site-1 sample

Table 1 Illustrated various parameters of samples from three different sites and showed limited range of pH (6.5-8.5), by Auto pH Meter, Alkalinity of Water was calculated by acid base titration method and values are 228.3 ±0.57, 225± 0.57, 236± 0.57 respectively for the three samples. The TDS also measured by (DREL 2000 HACH, INDIA) and values also shown that within the range of 400-500 mg/l..

Presence of Polymer/additives in site-1 (Jurala):

After taking the water sample from the site treated with hydrogen peroxide which precipitates the other residues present in water and allowed stand for a while. Furthers the sample was filtered by using whatmann filter paper with mesh size of 250 µm. FTIR and LCMS studies for the filtered reside perfumed (Figure-2, 3). In Chromatogram/ Thermogram of 250µm sieve confirms the presence Carnauba wax is peak which is not a plastic it is a natural plant wax shown in GCMS spectra demonstrated that the presence of various types of the Polypropylenes, Non-woven fabrics low density of polythene bag fragments, polyethylenes, density of Polyethylene, and higher methacrylate copolymers (Figure-2).



	Polymer/Additive	EntryID	Qual[%]
1	Polyethylene, chlorinated, 48% chlorine (C1-C10 Cl2 omitted)	FLG-262	41
2	Polyethylene, chlorinated, 48% chlorine (C1-C20 Cl2 omitted)	FLG-262	41
3	Polyethylene, chlorinated, 48% chlorine (C1-C40 Cl2 omitted)	FLG-262	41
4	Polyethylene, chlorinated, 48% chlorine (C1-C10 Cl2 omitted)	FLG-262	41
5	Polyethylene, chlorinated, 48% chlorine (C1-C20 Cl2 omitted)	FLG-262	41
6	Polyethylene, chlorinated, 48% chlorine (C1-C40 Cl2 omitted)	FLG-262	41
7	Ethylene Propylene-dien terpolymer (C1-C40)	FLY-002	39
8	Polyethylene, chlorinated, 42% chlorine (C1-C10 Cl2 omitted)	FLG-261	39
9	Polyethylene, chlorinated, 42% chlorine (C1-C20 Cl2 omitted)	FLG-261	39
10	Polyethylene, chlorinated, 42% chlorine (C1-C40 Cl2 omitted)	FLG-261	39
11	Polyethylene, chlorinated, 42% chlorine (C1-C10 Cl2 omitted)	FLG-261	39
12	Polyethylene, chlorinated, 42% chlorine (C1-C20 Cl2 omitted)	FLG-261	39
13	Polyethylene, chlorinated, 42% chlorine (C1-C40 Cl2 omitted)	FLG-261	39
14	Ethylene Propylene-dien terpolymer (C1-C40)	FLY-002	39

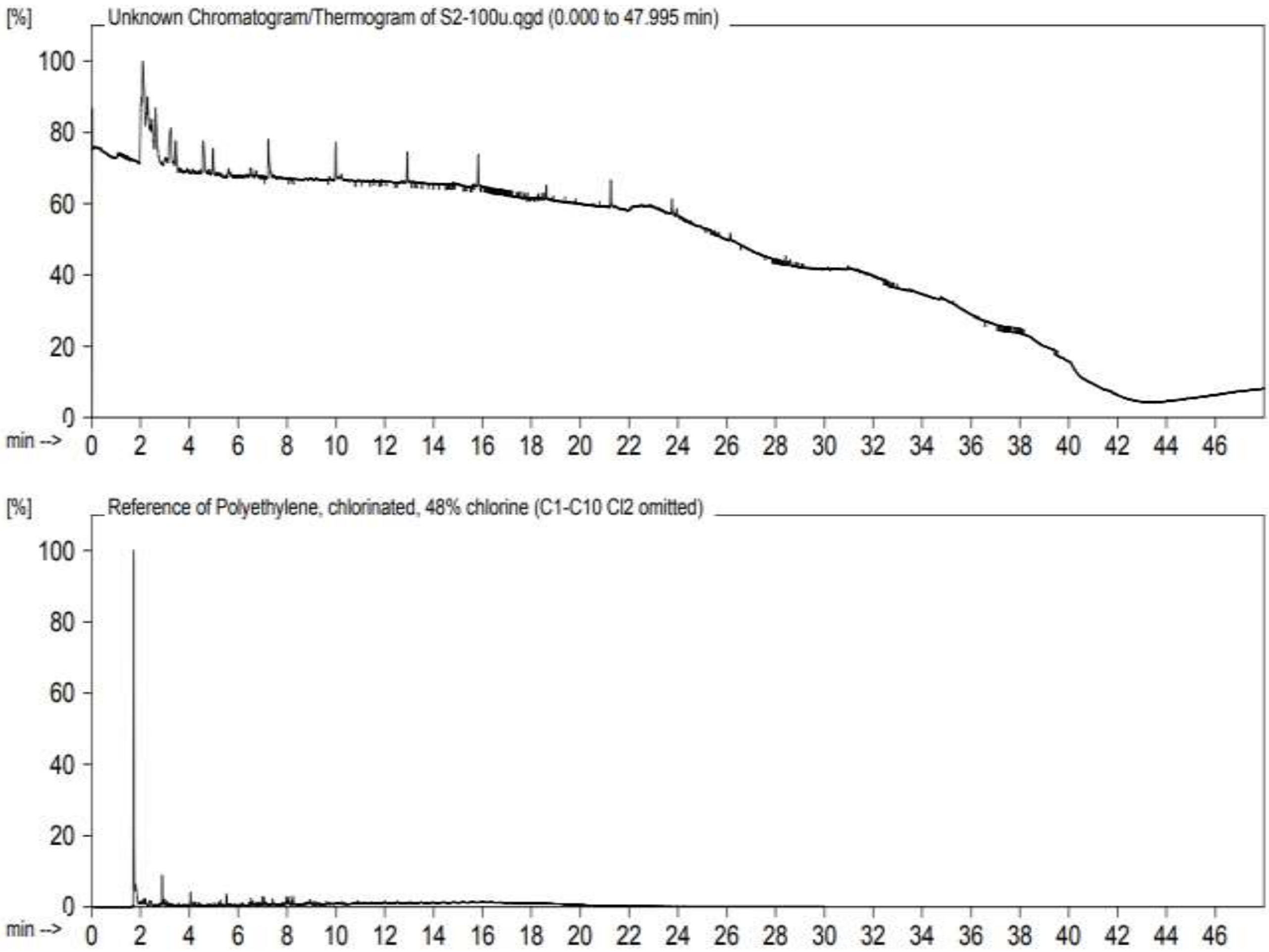
Figure-4. GCMS spectra of 100µm sieve sample residue at site-2

Presence of Polymer/additives in site-2 (Koilsagar):

Site-2 sample was filtered by using whatmann filter paper with mesh size of 100 µm. GCMS (Figure-4) and FTIR (Figure-5) studies for the filtered reside perfumed. In Chromatogram/ Thermogram of 100µm sieve and GCMS spectra, **Figure** illustrated the presence of two major polymers including Chlorinated polyethylenes, and ethylene propylene-diene terpolymer.

Presence of Polymer/additives in site-3 (Beechpally):

Site-3 sample was filtered by using whatmann filter paper with mesh size of 40 µm (Figure-6).



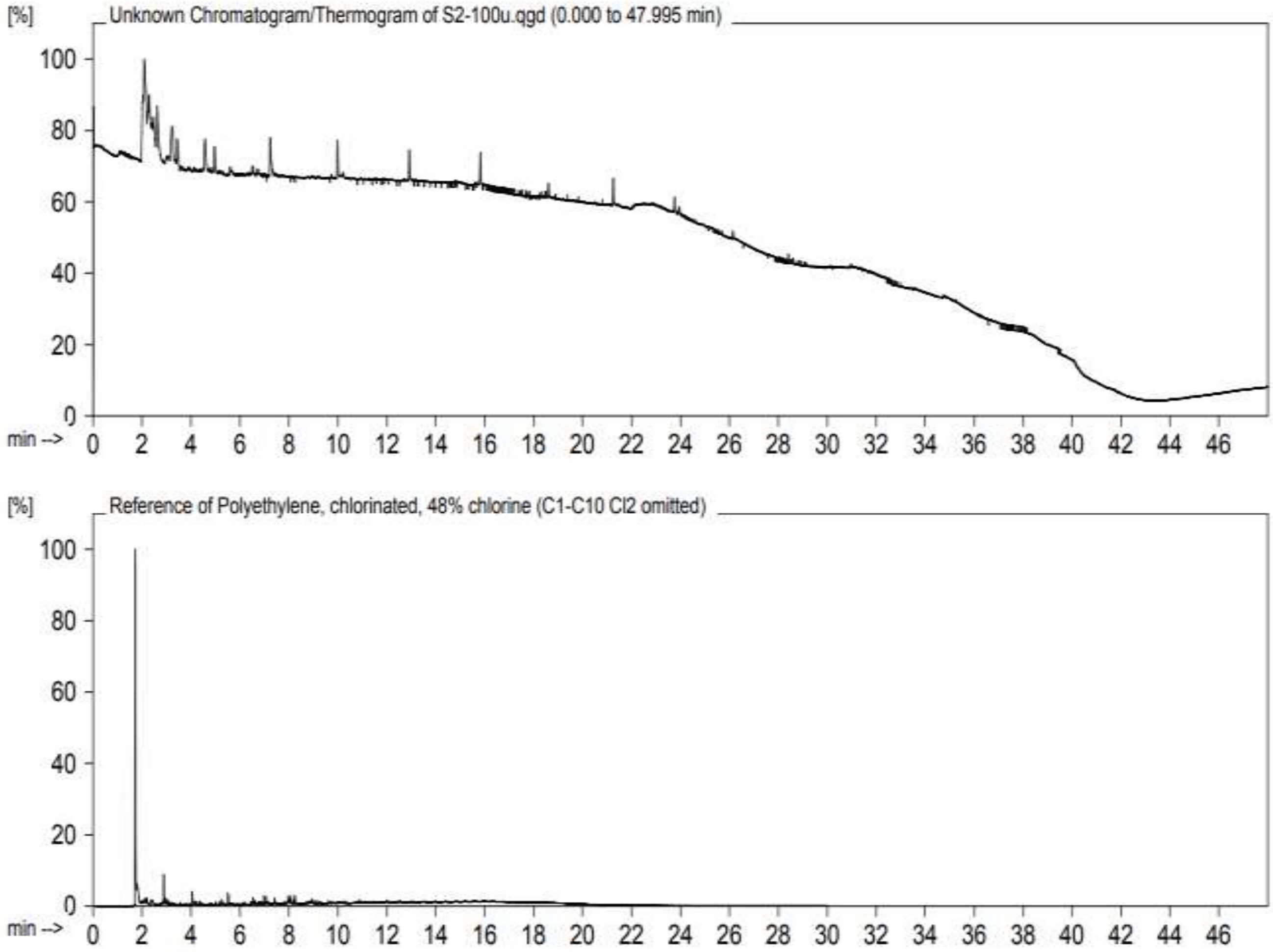
	Polymer/Additive	EntryID	Qual[%]
1	Polyethylene, chlorinated, 48% chlorine (C1-C10 Cl2 omitted)	FLG-262	41
2	Polyethylene, chlorinated, 48% chlorine (C1-C20 Cl2 omitted)	FLG-262	41
3	Polyethylene, chlorinated, 48% chlorine (C1-C40 Cl2 omitted)	FLG-262	41
4	Polyethylene, chlorinated, 48% chlorine (C1-C10 Cl2 omitted)	FLG-262	41
5	Polyethylene, chlorinated, 48% chlorine (C1-C20 Cl2 omitted)	FLG-262	41
6	Polyethylene, chlorinated, 48% chlorine (C1-C40 Cl2 omitted)	FLG-262	41
7	Ethylene Propylene-dien terpolymer (C1-C40)	FLY-002	39
8	Polyethylene, chlorinated, 42% chlorine (C1-C10 Cl2 omitted)	FLG-261	39
9	Polyethylene, chlorinated, 42% chlorine (C1-C20 Cl2 omitted)	FLG-261	39
10	Polyethylene, chlorinated, 42% chlorine (C1-C40 Cl2 omitted)	FLG-261	39
11	Polyethylene, chlorinated, 42% chlorine (C1-C10 Cl2 omitted)	FLG-261	39
12	Polyethylene, chlorinated, 42% chlorine (C1-C20 Cl2 omitted)	FLG-261	39
13	Polyethylene, chlorinated, 42% chlorine (C1-C40 Cl2 omitted)	FLG-261	39
14	Ethylene Propylene-dien terpolymer (C1-C40)	FLY-002	39

Figure 5. FTIR Spectra of 100μm sieve sample residue at site-2

FTIR and GCMS studies for the filtered reside perfumed. In Chromatogram/Thermogram of 40μm sieve and GCMS spectra **Figure-7**, confirms the presence of one major class of polymers that is Polyoxymethylenes.

CONCLUSION

In conclusion we have successfully analyzed three water samples of Krishna river from different sites and polymer compounds were characterized based on the GCMS and FTIR data. PE and PP are more prevalent than other materials because of their high manufacturing and widespread use of products that are essential to daily life, such as plastic bottles, bags, films, caps, and containers. Additionally, due to their low density, both PP and PE plastics are often buoyant and are easily carried through water, which increases their widespread presence in the environment. POM also known as acetal resin, polyacetal, polyacetal plastic, polytrioxane and polyformaldehyde, is



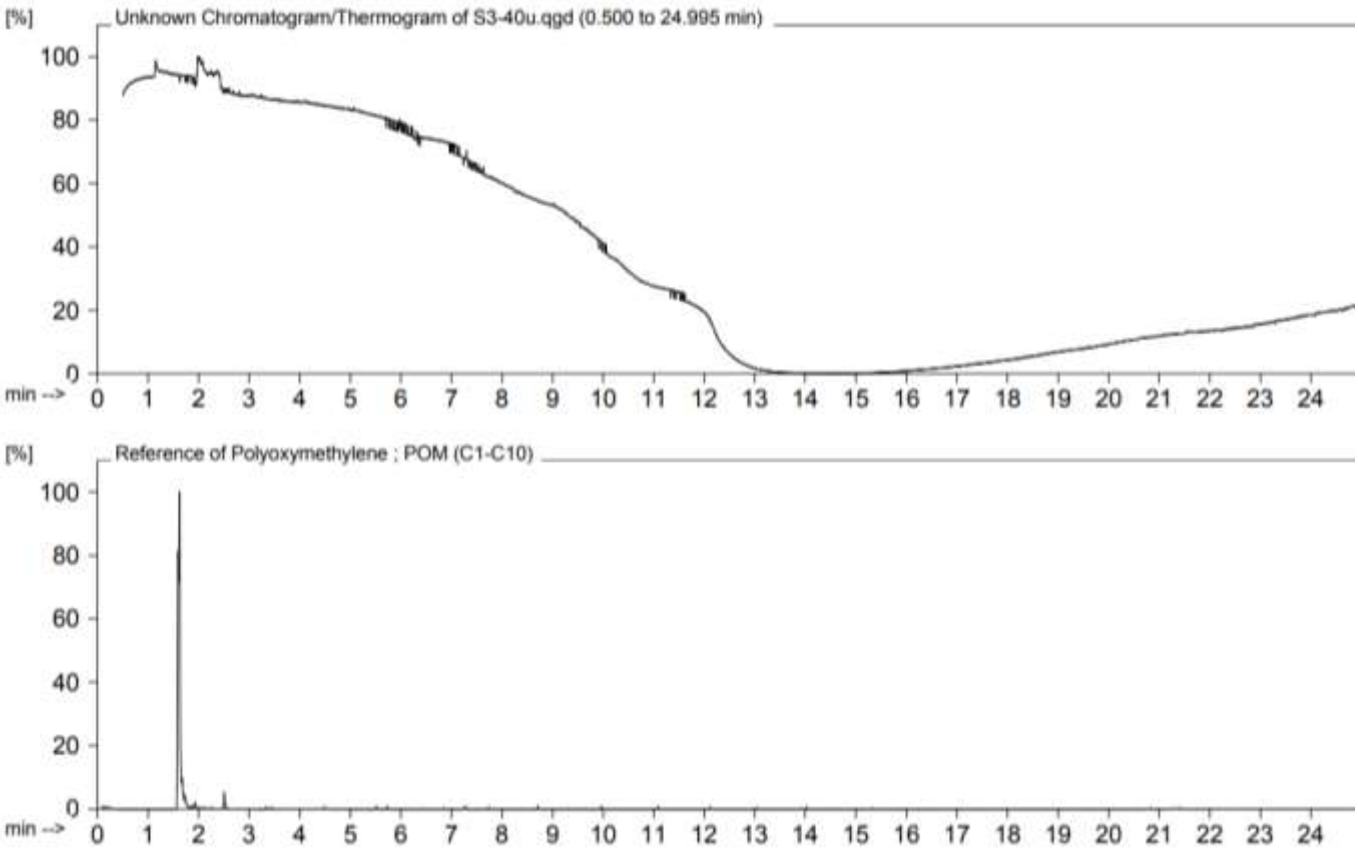
	Polymer/Additive	EntryID	Qual[%]
1	Polyethylene, chlorinated, 48% chlorine (C1-C10 Cl2 omitted)	FLG-262	41
2	Polyethylene, chlorinated, 48% chlorine (C1-C20 Cl2 omitted)	FLG-262	41
3	Polyethylene, chlorinated, 48% chlorine (C1-C40 Cl2 omitted)	FLG-262	41
4	Polyethylene, chlorinated, 48% chlorine (C1-C10 Cl2 omitted)	FLG-262	41
5	Polyethylene, chlorinated, 48% chlorine (C1-C20 Cl2 omitted)	FLG-262	41
6	Polyethylene, chlorinated, 48% chlorine (C1-C40 Cl2 omitted)	FLG-262	41
7	Ethylene Propylene-dien terpolymer (C1-C40)	FLY-002	39
8	Polyethylene, chlorinated, 42% chlorine (C1-C10 Cl2 omitted)	FLG-261	39
9	Polyethylene, chlorinated, 42% chlorine (C1-C20 Cl2 omitted)	FLG-261	39
10	Polyethylene, chlorinated, 42% chlorine (C1-C40 Cl2 omitted)	FLG-261	39
11	Polyethylene, chlorinated, 42% chlorine (C1-C10 Cl2 omitted)	FLG-261	39
12	Polyethylene, chlorinated, 42% chlorine (C1-C20 Cl2 omitted)	FLG-261	39
13	Polyethylene, chlorinated, 42% chlorine (C1-C40 Cl2 omitted)	FLG-261	39
14	Ethylene Propylene-dien terpolymer (C1-C40)	FLY-002	39

Figure-*6*. **Mass Spectrum of 40µm sieve showing Polyoxymethylene in peak.**

a semi-crystalline engineering thermoplastic, normally available in homopolymer or copolymer. The current investigation could be extremely helpful to determine the effects on Krishna river sub-basin dependent ecosystems.

Conflicts of Interest

Authors declare that there is no conflict of interests regarding the publication of this paper.



	Polymer/Additive	EntryID	Qual[%]
1	Polyoxymethylene ; POM (C1-C10)	FLG-501	65
2	Polyoxymethylene ; POM (C1-C10)	FLG-501	65
3	Polyacetal ; Poly(oxymethylene) ; POM [end-capped] (C1-C40)	FLK-158	65
4	Polyacetal ; Poly(oxymethylene) ; POM (C1-C40)	FLK-160	65
5	Polyoxymethylene ; POM (C1-C20)	FLG-501	64
6	Polyoxymethylene ; POM (C1-C20)	FLG-501	64
7	Polyoxymethylene ; POM (C1-C40)	FLG-501	64
8	Polyoxymethylene ; POM (C1-C40)	FLG-501	64
9	Polyoxymethylene ; POM (C1-C10)	FLT-091	63
10	Polyoxymethylene ; POM (C1-C20)	FLT-091	63
11	Polyoxymethylene ; POM (C1-C40)	FLT-091	63
12	Polyoxymethylene(copolymer) (C1-C10)	FLT-092	63
13	Polyoxymethylene ; POM (C1-C40)	FLT-091	63
14	Polyoxymethylene ; POM (C1-C10)	FLT-091	63

Figure 7. Chromatogram/Thermogram of 40μm sieve site-3

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