Adsorption Studies of Plant Base Oil and Mineral Oils on Tea Powder Waste

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Abstract- The natural plant based adsorbent (Tea powder) was activated by heating and treating it with 2N HCl and dried at 150oC for 2 hrs, stored and used for adsorption studies. The Groundnut oil, Coconut oil, Gingelly oils and Hydrocarbons like Hexane, Benzene, Kerosene, Petroleum ether and Toluene were selected for adsorption studies. The pH and heat had no effects on oil as it is inert to the same, at room temperature. The contact time and dose had effect on the adsorption which increases the adsorption with increase in the time and dose. The XRD spectral study of adsorbent before and after adsorption, confirms the adsorption process. The percentage of adsorption was calculated using spectrophotometry.

Index Terms- Adsorption, Tea powder, Mineral oil, Plant base oil, Contact time, XRD.

I. INTRODUCTION

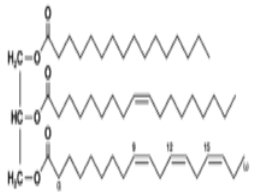
One of the most challenging environmental problems today is the removal of oil from waste water and storm water. A large amount of waste water is generated by industrial companies that produce or handle oil and other organic compounds, both immiscible and miscible in water. Some of these organic materials are discharged into the environment for example, offshore oil spills and oils released during oil well extraction.
Oily waste water discharged into the environment causes serious pollution problems since the biodegradability of oil is very low and oily waste water hinders biological processing at sewage treatment plants (Jose *et al.*, 2009). Petroleum and petrochemical plants are potential oil sources for polluting inland water caused by runoff from oil fields, refineries and process effluents (Johnson et al., 1973).

Removing oil contamination from water is a common problem with water from oilfields storm water run-off. Typical storm water run-off is often contaminated with oil, benzene, toluene, fuels and other contaminants from rooftops and pavement.

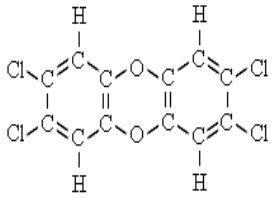
Current technologies for oil removal include Skimming, filtration, gravity separation, induced flotation, ultra filtration, adsorption and biological treatment. An oil and water mixture can be classified as free oil (Manual, 1969) for oil droplets larger than 150µm, dispersed oil with oil droplets in the range of 20-150µm and emulsified oil with oil droplets smaller than 20µm (Manning and Snider, 1983). Waste water, where the oil in the oil-water mixture is not present in the form of droplets. Biological treatment of oil-water mixtures is limited only to low concentrations of oil in water since the microorganisms do not tolerate high oil concentrations and therefore its use is limited to very specific applications. With the increase of population and development of society, waste water treatment became necessary in most places. Pollutants removal is the main objective in this situation (Zhang Guangming, 2011).

In the present day scenario, one of the key point of prevention and minimization of pollution is recycling of starting materials. This separation process may not only solve the economy but will potentially help keeping the environment clean (Pal Anjali, 2008). In this paper, we have made an attempt to remove the oil from water using natural adsorbent i.e, Tea waste. The oils selected for our study are Gingili, Coconut, Ground nut, Hexane, Petroleum ether, Benzene, Toluene, Kerosene as plant and mineral oils.

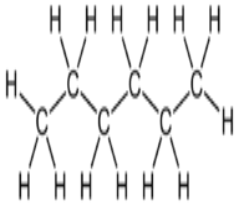
Structures of Plant base oil and Mineral oil.



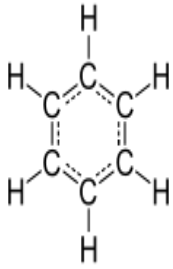
Triglyceride (Plant oil)



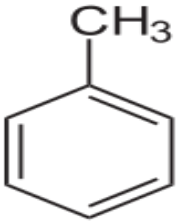
Kerosene



Hexane



Benzene



Toluene

II. MATERIALS AND METHODS

Processing of Tea waste for adsorption:

Tea waste was cleaned with tap water then treated with 2N HCl. Once again it was washed and pH was maintained at neutral condition, heated for 2 hrs and used for adsorption study.

Preparation of oil solution:

The plant and mineral oils like Coconut oil, Ground nut oil, Gingely oil, Benzene, toluene, Petroleum ether and Kerosene were selected for adsorption study.

1ml of oil was directly added to100 ml of distilled water. The immiscible solution was mechanically churned (Emulsified) and immediately initial optical intensity was noted for the all the oils. Solution was used for adsorption process.

The percentage of adsorption was calculated by the formula:

$P=I_0/I$ X 100, where, I_o is the Final optical density, I is the Initial optical density.

Batch Experiment:

Oil adsorption was conducted with 50ml stock solution. The variables studied were adsorbent dose, concentration of adsorbate, pH and contact time.

III. Result and Discussion

The effects of parameters like pH, dose of adsorbent and contact time on the removal of oil in aqueous media was investigated with respect to tea waste (natural adsorbent).

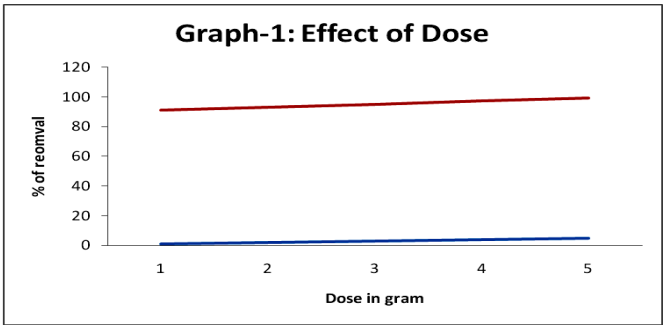
i. Effect of pH: Oil does not get affected either by acid or alkali unless heat was applied.
ii. Effect of temperature: Oil was heat resistant. But reacts with acid or base while heating.
iii. Effect of dose: 50 ml of 1% oil solution was taken in series of beakers, 2-5g of adsorbent was added and kept for adsorption for 48 hrs. The result showed that, as dose increases, adsorption increases (graph-1).
iv. Effect of contact time: 50 ml of 1% oil solution was taken, 2g of adsorbent was added and kept for adsorption. As contact time increased adsorption increased.

Note: i. The adsorbent and adsorbate should be agitated for higher removal efficiency.

ii. Tea powder has low density than water and floats on surface of water. When tea powder comes in contact with oil, oil get adsorb on surface of tea powder, then the density of tea powder increases and settles at bottom which confirms the saturation point (adsorption) of tea powder.

Fig-1: The immiscible oil before and after adsorption using tea waste.

Fig-2: The graph showing relation between dose and adsorption.



Statistical analysis for Dose Vs Contact time(R value).

The correlation coefficient value 0.976 shows favorable relation with increase in dose and time of all the oils with that of adsorbent.

Oil removed	Percentage removal (Initial reading/Final reading X 100)
Ground nut oil	90.96 %
Gingelly oil	85.72 %
Coconut oil	93.44 %
Petroleum ether	80.55 %
Toluene	83.63 %
Benzene	80.55 %
Hexane	82.27 %
Kerosene	72.82 %

Table-1: Percentage removal of different types of oils.

IV. Discussion and Conclusion

Comparing diffraction patterns from the tea surface before and after the adsorption of oils, it was confirmed the adsorption and the intensity was as follows:

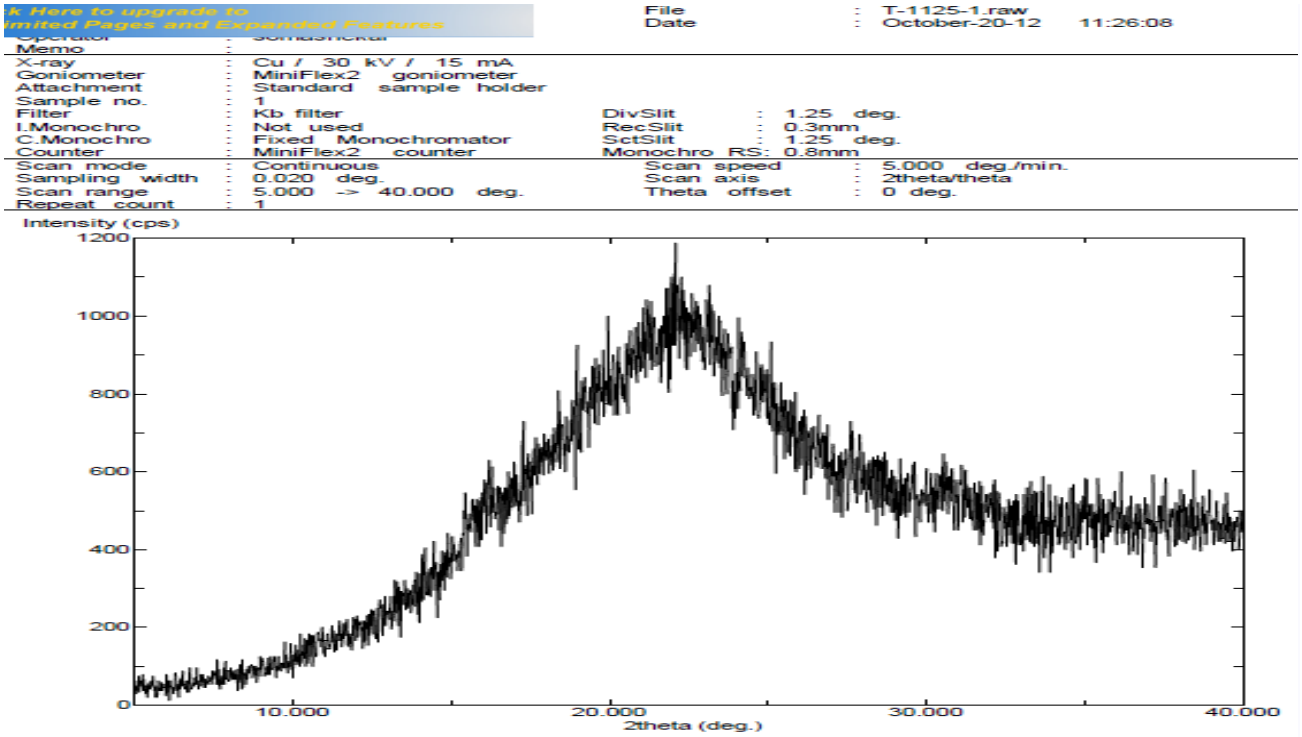
The intensity of the tea powder without adsorption was 1100 cps in XRD spectrum-1, when compared with the XRD spectra of waste Tea powder adsorbed with Gingili oil (XRD-2), Coconut oil (XRD-3), Ground nut oil(XRD-4), Benzene(XRD-5), Kerosene (XRD-6), Petroleum ether (XRD-7), Toluene (XRD-8) and Hexane (XRD-9) showed the peaks at the intensity of 900, 1750, 1600, 1100, 1750,1500, 1000 and 1200 cps respectively.

Hence the tea powder waste can be used as adsorbent for the removal of plant base and mineral oils from oil contaminated water.

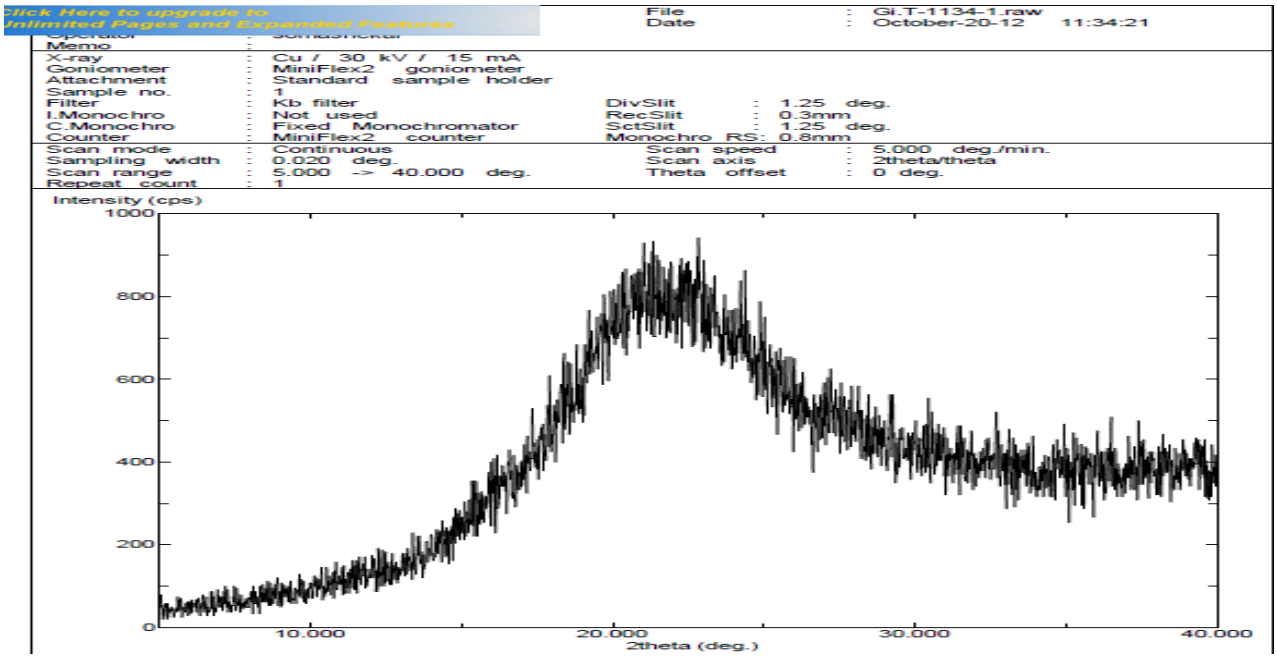
APPENDICES

XRD spectra of Tea powder before and after adsorption of the plant oils and Hydrocarbon:

XRD-1

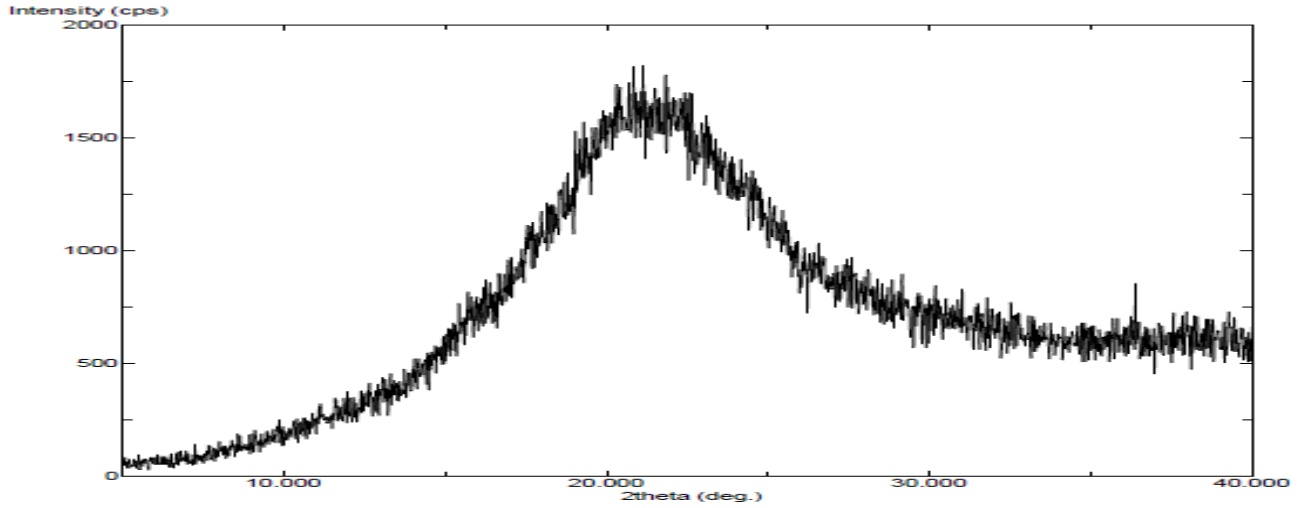


XRD-2



XRD-3

			File	:	CNT-1116-1.raw
			Date	:	October-20-12 11:17:17
Operator	:	Somashekar			
Memo	:				
X-ray	:	Cu / 30 kV / 15 mA			
Goniometer	:	MiniFlex2 goniometer			
Attachment	:	Standard sample holder			
Sample no.	:	1			
Filter	:	Kb filter	DivSlit	:	1.25 deg.
I.Monochro	:	Not used	RecSlit	:	0.3mm
C.Monochro	:	Fixed Monochromator	SctSlit	:	1.25 deg.
Counter	:	MiniFlex2 counter	Monochro RS:		0.8mm
Scan mode	:	Continuous	Scan speed	:	5.000 deg./min.
Sampling width	:	0.020 deg.	Scan axis	:	2theta/theta
Scan range	:	5.000 -> 40.000 deg.	Theta offset	:	0 deg.
Repeat count	:	1			



XRD-4

			File	:	GNT-1142-1.raw
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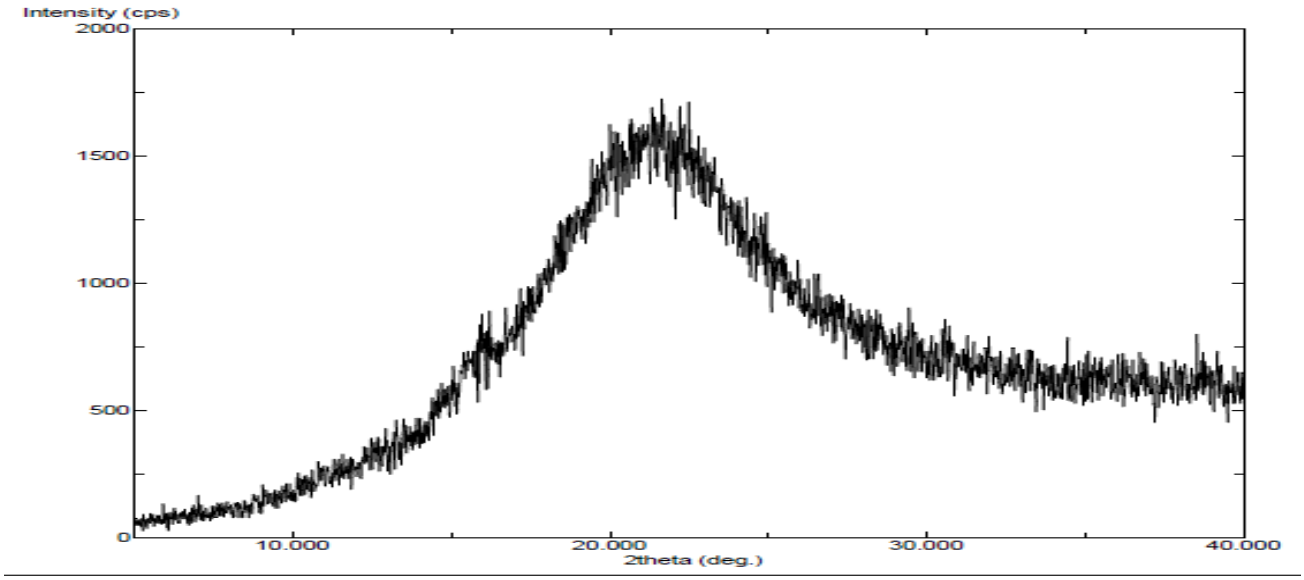
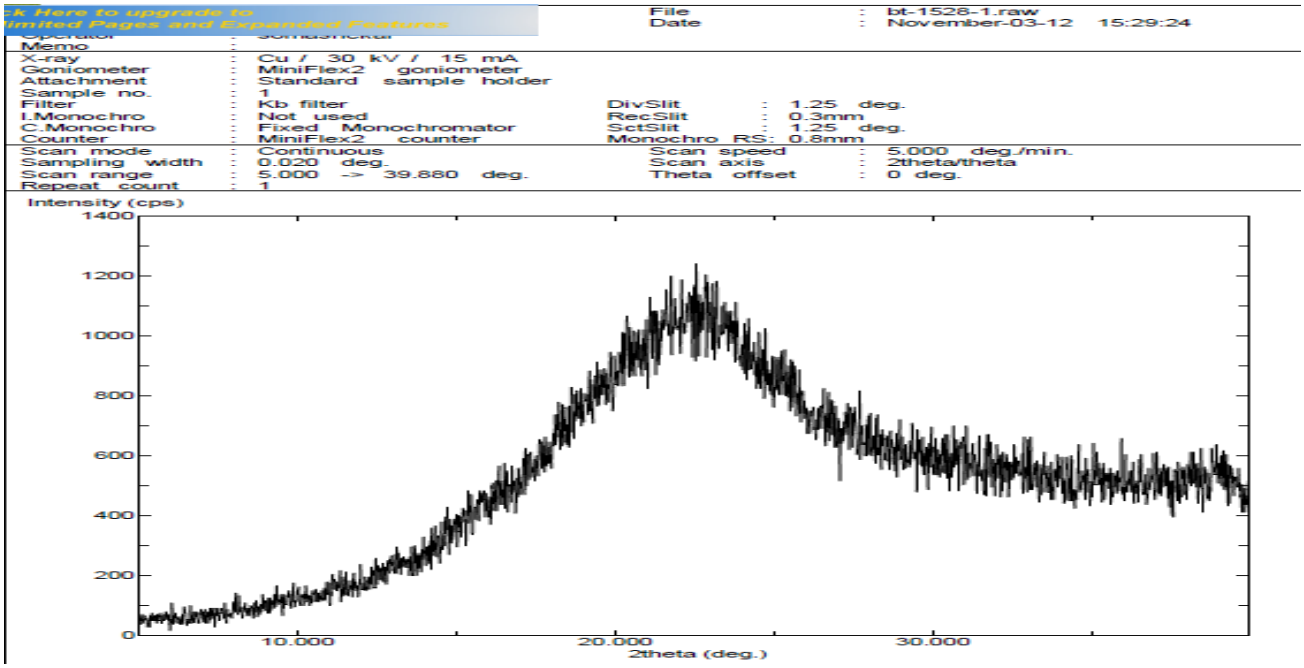
Memo	:				
X-ray	:	Cu / 30 kV / 15 mA			
Goniometer	:	MiniFlex2 goniometer			
Attachment	:	Standard sample holder			
Sample no.	:	1			
Filter	:	Kb filter	DivSlit	:	1.25 deg.
I.Monochro	:	Not used	RecSlit	:	0.3mm
C.Monochro	:	Fixed Monochromator	SctSlit	:	1.25 deg.
Counter	:	MiniFlex2 counter	Monochro RS:		0.8mm
Scan mode	:	Continuous	Scan speed	:	5.000 deg./min.
Sampling width	:	0.020 deg.	Scan axis	:	2theta/theta
Scan range	:	5.000 -> 40.000 deg.	Theta offset	:	0 deg.
Repeat count	:	1			



XRD-5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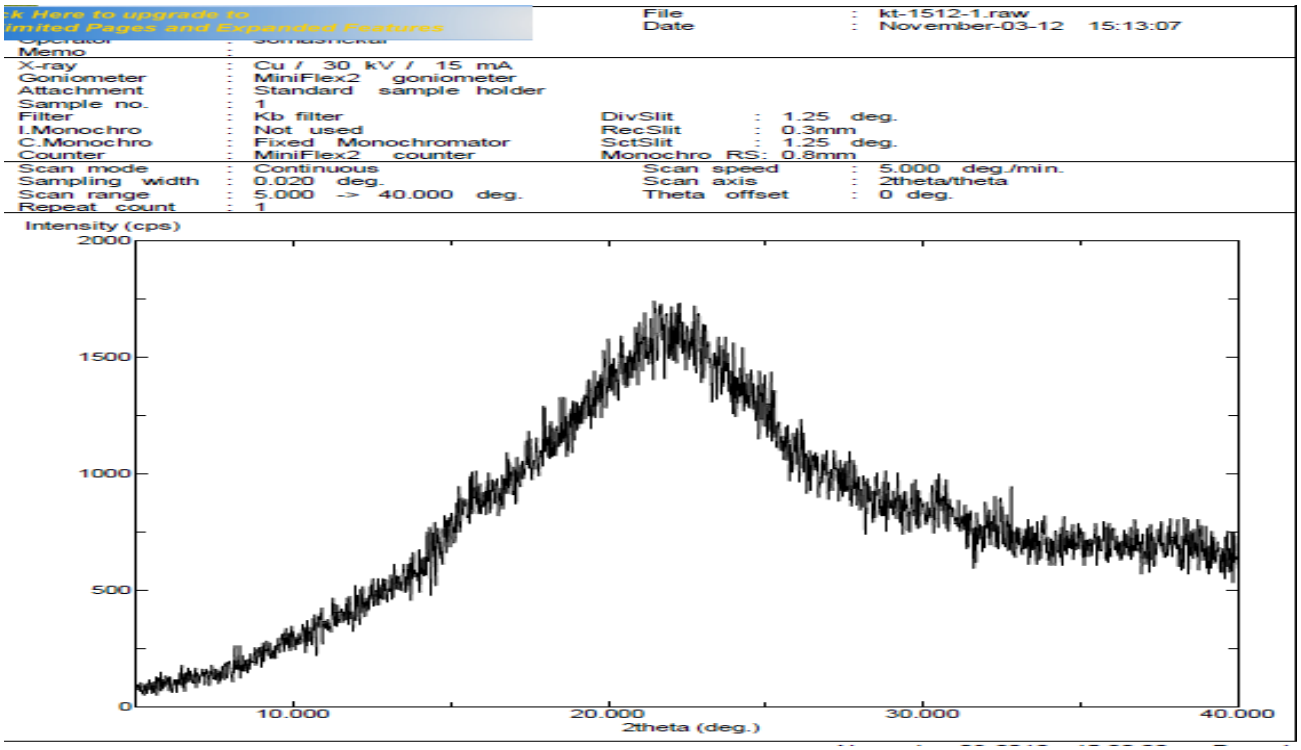
Memo :
X-ray : Cu / 30 kV / 15 mA
Goniometer : MiniFlex2 goniometer
Attachment : Standard sample holder
Sample no. : 1
Filter : Kb filter
I.Monochro : Not used
C.Monochro : Fixed Monochromator
Counter : MiniFlex2 counter
DivSlit : 1.25 deg.
RecSlit : 0.3mm
SctSlit : 1.25 deg.
Monochro RS: 0.8mm
Scan mode : Continuous
Sampling width : 0.020 deg.
Scan range : 5.000 -> 39.880 deg.
Repeat count : 1
Scan speed : 5.000 deg./min.
Scan axis : 2theta/theta
Theta offset : 0 deg.
Intensity (cps)
1400
1200
1000
800
600
400
200
0
10.000
20.000
30.000
2theta (deg.)

XRD-6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Memo :
X-ray : Cu / 30 kV / 15 mA
Goniometer : MiniFlex2 goniometer
Attachment : Standard sample holder
Sample no. : 1
Filter : Kb filter
I.Monochro : Not used
C.Monochro : Fixed Monochromator
Counter : MiniFlex2 counter
DivSlit : 1.25 deg.
RecSlit : 0.3mm
SctSlit : 1.25 deg.
Monochro RS: 0.8mm
Scan mode : Continuous
Sampling width : 0.020 deg.
Scan range : 5.000 -> 40.000 deg.
Repeat count : 1
Scan speed : 5.000 deg./min.
Scan axis : 2theta/theta
Theta offset : 0 deg.
Intensity (cps)
2000
1500
1000
500
0
10.000
20.000
30.000
40.000
2theta (deg.)

XRD-7

			File	:	pet-1503-1.raw
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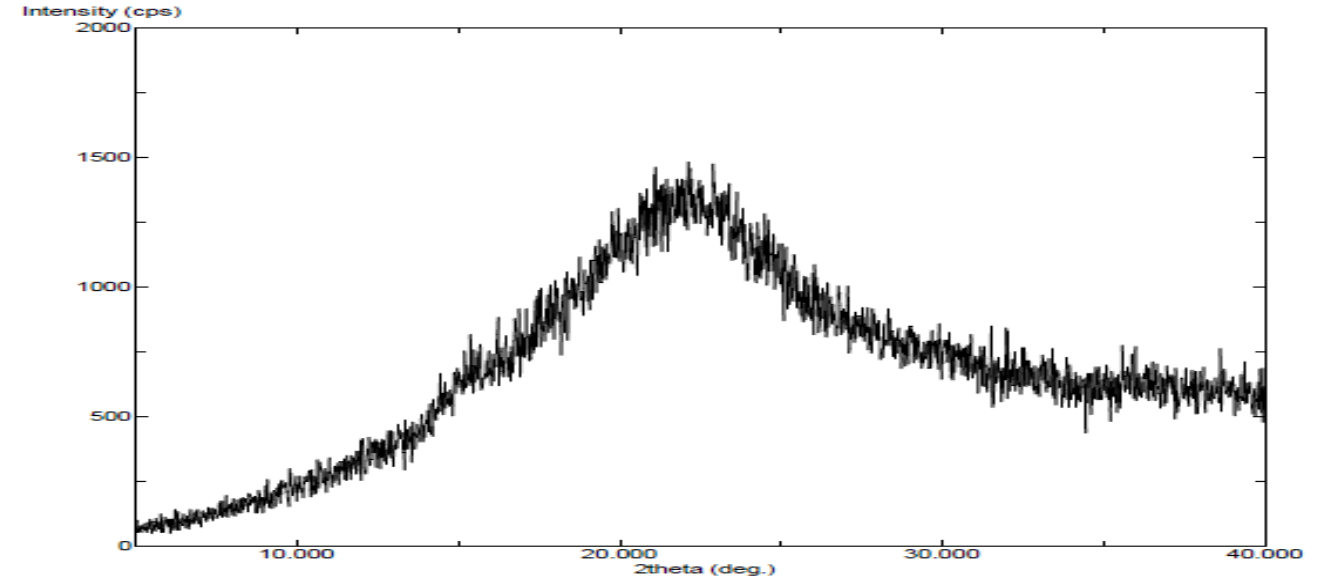
Memo	:				
X-ray	:	Cu / 30 kV / 15 mA			
Goniometer	:	MiniFlex2 goniometer			
Attachment	:	Standard sample holder			
Sample no.	:	1			
Filter	:	Kb filter	DivSlit	:	1.25 deg.
I.Monochro	:	Not used	RecSlit	:	0.3mm
C.Monochro	:	Fixed Monochromator	SctSlit	:	1.25 deg.
Counter	:	MiniFlex2 counter	Monochro RS:		0.8mm
Scan mode	:	Continuous	Scan speed	:	5.000 deg./min.
Sampling width	:	0.020 deg.	Scan axis	:	2theta/theta
Scan range	:	5.000 -> 40.000 deg.	Theta offset	:	0 deg.
Repeat count	:	1			



XRD-8

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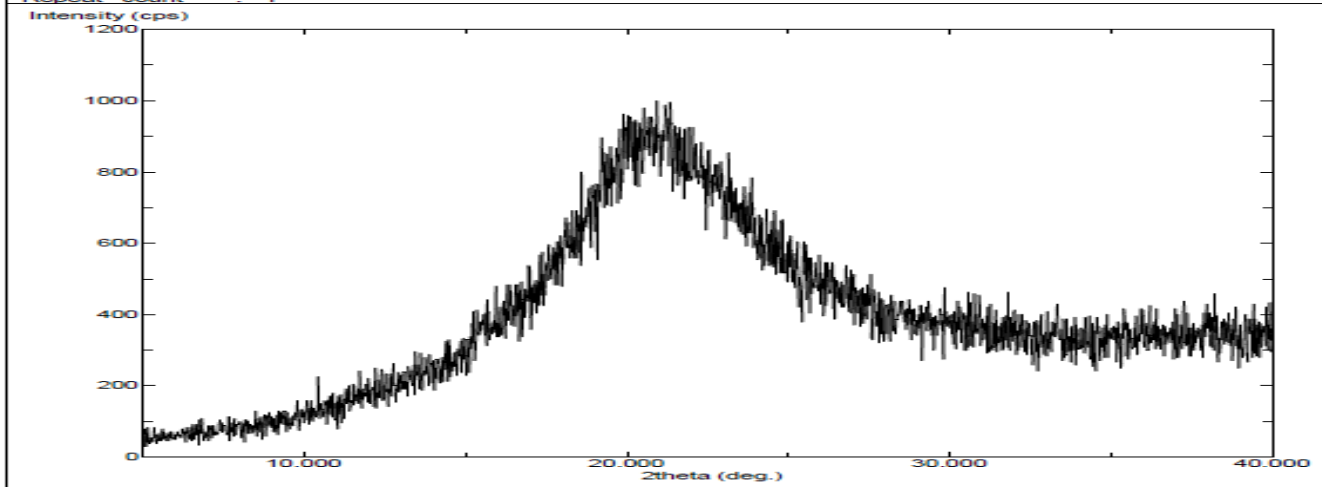
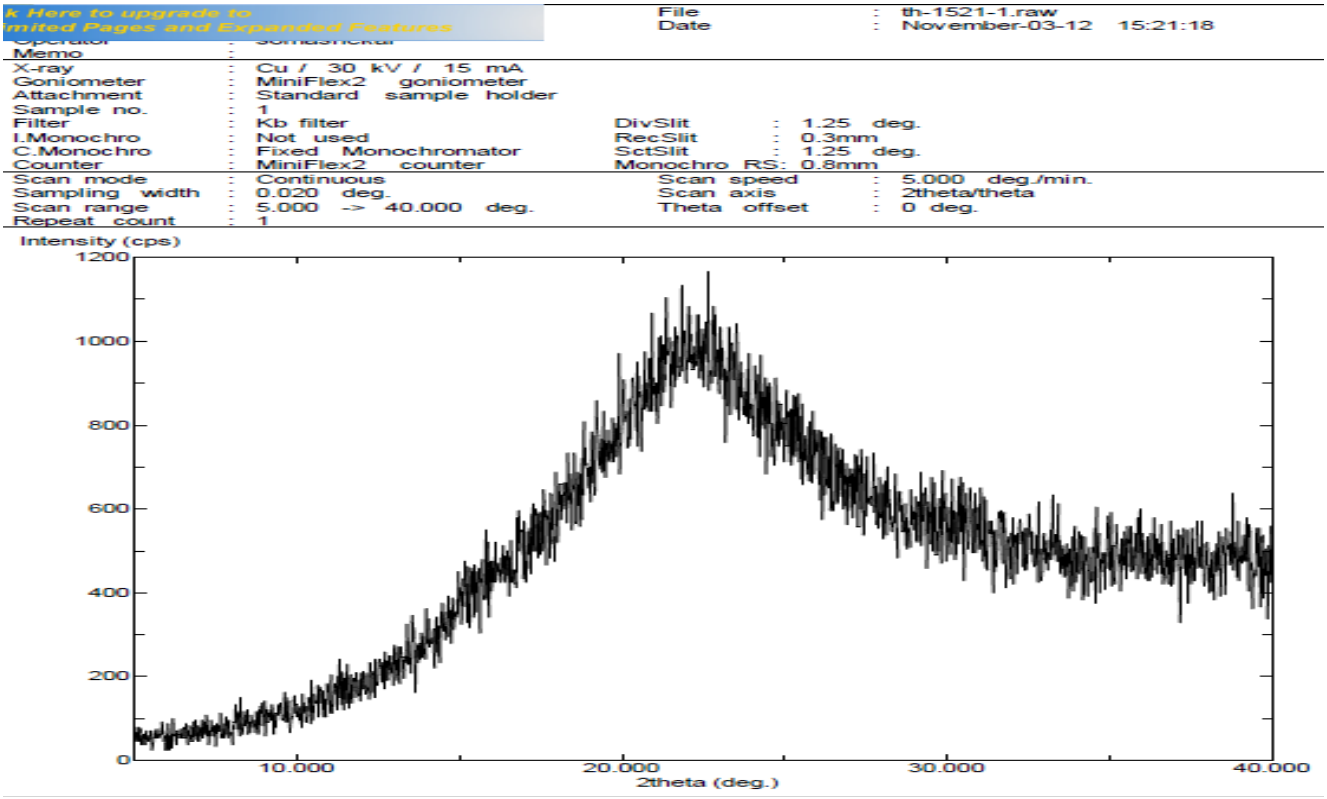
Memo	:				
X-ray	:	Cu / 30 kV / 15 mA			
Goniometer	:	MiniFlex2 goniometer			
Attachment	:	Standard sample holder			
Sample no.	:	1			
Filter	:	Kb filter	DivSlit	:	1.25 deg.
I.Monochro	:	Not used	RecSlit	:	0.3mm
C.Monochro	:	Fixed Monochromator	SctSlit	:	1.25 deg.
Counter	:	MiniFlex2 counter	Monochro RS:		0.8mm
Scan mode	:	Continuous	Scan speed	:	5.000 deg./min.
Sampling width	:	0.020 deg.	Scan axis	:	2theta/theta
Scan range	:	5.000 -> 40.000 deg.	Theta offset	:	0 deg.
Repeat count	:	1			



XRD-9



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