PLASTIC TO FUEL: THE EFFECT OF REAL PLASTIC WASTES COMPOSITION

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Thesis submitted in partial fulfilment of the requirements
for the award of the degree of
Bachelor of Chemical Engineering

Faculty of Chemical & Natural Resources Engineering
UNIVERSITI MALAYSIA PAHANG

JANUARY 2017

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Dedicated to my father, and my mother. They are reason of my existence and the only reason I keep going

ACHIEVEMENTS

Leading Innovation Award (Special award)- Macau Innovation and Invention Association, Gasoline from plastic waste by using biomass ash catalyst via zero waste process, Kaoshiung International Invention and Design Expo, (KIIDE 2016)-Kaoshiung, Taiwan, 9-11 December (2016)

Gold medal- Gasoline from plastic waste by using biomass ash catalyst via zero waste process, Kaoshiung International Invention and Design Expo, (KIIDE 2016)-Kaoshiung, Taiwan, 9-11 December (2016)

Gold medal- Waste to Energy: Gasoline-diesel fuel production from plastic waste via zero-waste process, International Festival Innovation on Green Technology (IFINOG) 2016-Universiti Malaysia Pahang, 15-17 April (2016)

Gold medal- Waste to Energy: Gasoline from plastic waste via zero waste process International Engineering Invention and Innovation Exhibition (i-ENVEX) 2016-Universiti Malaysia Perlis, 8-10 April (2016)

Gold medal- Waste to Energy: Fuel from plastics waste by using biomass ash catalyst, Creation, Innovation, Technology, Innovation & Research Exposition (CITREX)-Universiti Malaysia Pahang, 7-8 March (2016)

ACKNOWLEDGEMENT

The following thesis benefited from the insights and direction of several people. First, I must acknowledge Dr. Ruzinah Isha for her guidance, support and direction as well as her patience in dealing with me. She has taught me so much not only about pyrolysis of plastic's but also about life. I am deeply and eternally grateful to her and I feel very fortunate to have had the opportunity to have her as an advisor.

In addition to the guidance and technical assistance above, I received equally important assistance from family and friends. My beloved parents, Ali Kucheb and Faiz Azmy provided on-going support throughout the thesis process. And finally, I would like to thank my friends, who know who they are, for keeping me sane during this period and enhancing the time I spent at the Universiti Malaysia Pahang. I would also like to give my gratitude to Faculty of Chemical Engineering for the financial support and the facilities provided to run the research.

ABSTRACT

Plastic is a major composition in municipal waste. Depleting of fossil fuel leads to exploration of alternative fuel production including converting plastic waste to fuel. The objective of this of study is to investigate the effect of real plastic waste composition on a pyrolysis process to fuels. Plastic wastes that compose of shampoo bottle, plastic bag, plastic wrapper and polystyrene were used. Thermal decomposition study of the plastic wastes was done by using Thermogravimetric Analysis. The catalyst used in this research is oil palm biomass ash catalyst. It was cleansed and calcined at 750°C (15°C.min^{-1}) for four hours. Then, the catalyst was then crushed and sieved to have homogenized size of < 125µm. The catalyst was characterized by using Scanning Electron Microscope (SEM) with Energy Dispersive X-Ray (EDX) and Brunauer, Emmett and Teller (BET). Nitrogen gas was used to provide oxygen free condition during the investigation. The plastic waste and catalyst weight ratio was set at 10:1. The catalyst was tested in a batch one litre borosilicate reactor and heated up to 450 °C for 30 minutes. The plastic wastes decomposed into liquid, solid residue and gas. The liquid product was collected in a condenser, while the uncondensed gas was collected in the gas bag. The composition of the liquid fuel was analyzed by using Mass spectrometry gas chromatography (GC-MS). The calorific value, moisture, density, turbidity, cetane and octane number of the liquid fuel were also determined. Gas composition of the gas product was determined via Thermal Conductivity Detector gas chromatography (GC-TCD). About 40% of liquid fuel was produced after the pyrolysis for shampoo bottle. The application of catalyst significantly improved the liquid production to 50% of liquid fuel. Liquid fuel quality with averagely high octane number for shampoo bottle and polystyrene are 100 and 98 respectively. Low moisture content (<3 %) was observed in all liquid fuels. The calorific value ranging from 2885.36 cal/g - 4209.31 cal/g was achieved for all plastics samples. A gas product that rich in methane (±3mol%) was obtained. In conclusion, the application of catalyst that derived from waste creates a low cost alternative fuel production via catalytic plastic waste pyrolysis.

ABSTRAK

Bahan fosil api yang semakin berkurang mengilhamkan kaedah bahan api alternatif termasuk menukar sisa plastik kepada bahan api. Objektif pengajian ini adalah untuk mengkaji kesan komposisi plastic sampah sebenar pada proses pirolisis kepada bahan api. Sisa plastik yang dikomposisikan daripada botol syampu, beg plastik, plastik pembungkus dan polistirena, telah digunakan. Kajian penguraian terma bagi sisa plastik telah dilakukan dengan menggunakan 'Thermogravimetric Analysis'. Pemangkin yang digunakan dalam kajian ini adalah pemangkin abu kelapa sawit. Ia telah dibersihkan dan dikalsin pada 750°C dengan 15°C.min^{-1} selama empat jam. Kemudian, pemangkin telah dihancurkan dan disaring untuk mempunyai saiz <125μm. Pemangkin telah dicirikan dengan menggunakan 'Scanning Electron Microscope' (SEM) dengan 'Energy Dispersive X-Ray' (EDX) dan 'Brunauer, Emmett and Teller' (BET). Gas nitrogen telah digunakan untuk menyediakan keadaan bebas oksigen semasa siasatan dijalankan. Sisa dan pemangkin nisbah berat plastik telah ditetapkan pada 10:1. Pemangkin ini telah diuji di dalam satu liter borosilikat reaktor dan dipanaskan sehingga 450° C selama 30 minit. Sisa plastik telah diuraikan kepada cecair, sisa pepejal dan gas. Produk cecair telah dikumpulkan di dalam pemeluwap, manakala gas yang tidak meluwap telah dikumpulkan dalam beg gas. Komposisi bahan api cecair telah dianalisis dengan menggunakan 'Mass spectrometry gas chromatography' (GC-MS). Jumlah nilai kalori, kelembapan, ketumpatan, kekeruhan, cetana dan oktana bahan api cecair juga telah ditentukan. Komposisi gas produk gas telah dianalisis melalui 'Thermal Conductivity Detector gas chromatography' (GC-TCD). Sebanyak 40% bahan api cecair diperloleh selepas pirolisi. Pengunaan pemangkin menunjukkan peningkatan yang ketara kepada 50% bahan api cecair. Kualiti bahan api cecair dengan purata nombor yang tinggi iaitu 100 oktana untuk botol syampu dan 98 untuk polistirena, kandungan lembapan yang rendah (< 3%). Rangkaian nilai kalori petrol yang bermula daripada 2885.36 kalori/g – 4209.31 kalori/g dan produk gas yang kaya dengan metana (± 3 mol%) telah diperolehi untuk semau jenis plastik. Kesimpulannya, pengunaan pemangkin yang terhasil daripada sisa menghasilkan bahan api alternatif yang berkos rendah.
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LIST OF ABBREVIATIONS

HDPE – High density polyethylene

LDPE – Low density polyethylene

PE – Polyethylene

PP – Polyethylene

PS – Polystyrene

SPI – Society of Plastic Industry

GC – Gas Chromatography

MS – Mass Spectrometry

TGA – Thermal Gravimetric Analysis

SEM – Scanning electron microscope

POMA – Palm Oil Mill Ash

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Plastic is a high molecular weight material that was invented by Alexander Parkes in 1862 (Brydson, J.A 1999). Plastics are made off inorganic and organic raw materials, such as carbon, silicon, hydrogen, nitrogen, oxygen and chloride. The basic materials used for making plastics are extracted from oil, coal and natural gas (Seymour, 1989). Plastics are made off long chain polymeric molecules (Scott, 1999). Plastics are not presently biodegradable and are extremely troublesome components for landfilling (Ali et al., 2004). In order to assist recycling of the waste plastic, Society of Plastic Industry (SPI) defined a resin identification code system that divides plastics into seven groups based on the chemical structure and applications (The Society of the Plastic Industry [SPI], 1999) They are:

I. PET (Polyethylene Terephthalate)
II. HDPE (High Density Polyethylene)
III. PVC (Polyvinyl Chloride)
IV. LDPE (Low Density Polyethylene)
V. PP (Polypropylene)
VI. PS (Polystyrene)
VII. Other

Those seven types of plastics are marked on various plastic products as (The Society of the Plastic Industry [SPI], 1999):

Figure 1.1: Marks of the seven types of plastics on various plastic products (The Society of the Plastic Industry [SPI], 1999)

Due to the convenience to manufacturing and use, Malaysian domestic plastic production has been increasing since 2001 from RM 4.78 billion to RM 7.25 billion in 2013 as shown in Figure 1-2. (Department of Statistics MATRADE, Malaysia).

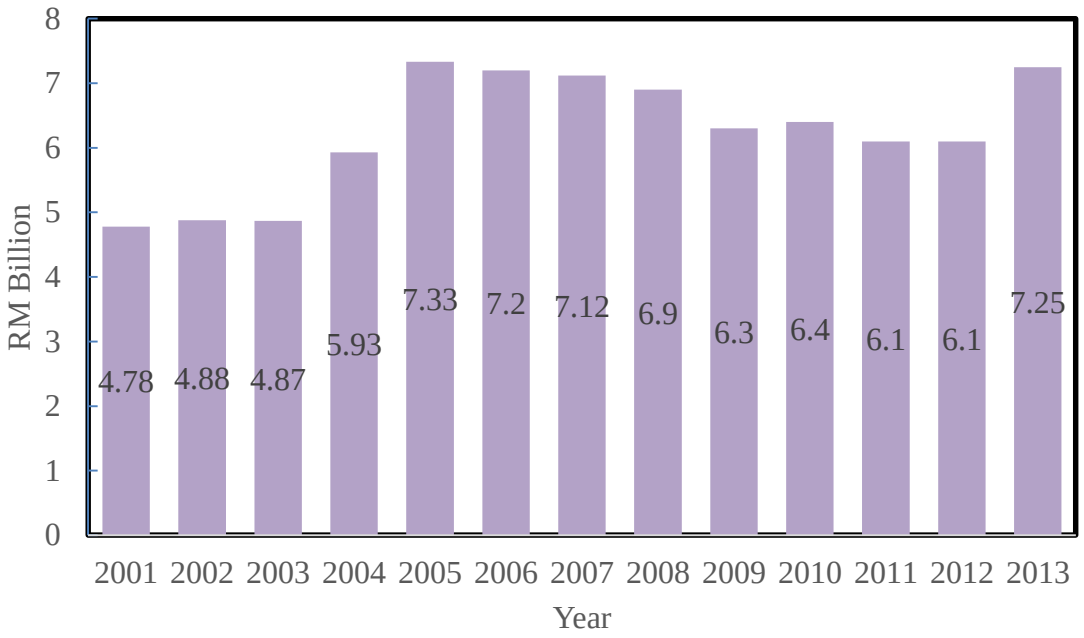

Figure 1.2: Domestic Production of plastic from 2001 till 2013 (Department of Statistics MATRADE, Malaysia)

One of the major concerns for extensive use of the plastics is the disposal of the waste plastic. Since 1999 till 2009, municipal solid waste in Malaysia has increased about 46% (27284 tonnes/day) and 19% of it is plastic waste (Agamuthu and Fauziah, 2009). Plastic waste is hard to decompose naturally and they are non-degradable material. Several method of solid waste disposal is introduced to manage the municipal solid waste such as recycling, composting, incineration, inert landfills, and sanitary landfill, but most of them is not very favorable in term of cost (incineration technology), and area capability for landfilling. Malaysian laws are too general and unsatisfactory

due to lack of resources and municipal budget constraint. The budget for waste collection was ranging from 20% to 70%, based on the size of the municipality (Hassan et al., 2000). Waste are also dumped in the river. For example, it is reported that 31.9% of waste were disposed by open burning, while 6.5% were dumped into the river system in Kuala Lumpur alone (Murad and Siwar, 2007). This has triggered to find an alternative solution for solid waste management where it is affordable and has a great turnover benefit. Pyrolysis is the future process for waste management and alternative energy source. Pyrolysis of plastic was introduced in the early 90's and still being carry out until today. The process has a wide range of potential market including the conversion of plastic to gasoline-diesel fuel (Buekens & Huang, 1998) and the solid product produce can be use as charcoal and fertilizer (Iwuagwu and Ugwuanyi, 2014). However, the optimum pyrolysis process is still ongoing.

1.2 Motivation

Municipal solid waste generation in Malaysia has increased significantly ranging between 25000 – 30000 tons per day (Johari et al., 2014). This shows that the municipal solid waste in Malaysia has not been handle properly in term of the method of the managing solid waste. Besides that, crude oil reserves are vanishing at the rate of 4 billion tonnes a year, and if we continue at this rate without any increase for our growing population or aspiration, our known reserves will be gone by 2052 (Tathagat et al., 2015). The pyrolysis technology can assist reducing this problem by generating alternative energy source. Moreover, the final motivation is regarding oil palm mill ash. Oil palm mill generates large quantities of oil palm product which lead to generate a strong pollutant; amenable to microbial degradation because it is rich in carbon, nitrogen, and minerals. (Iwuagwu and Ugwuanyi, 2014). Oil palm mill ash from oil palm mill boiler is also rich in metal mineral including alumina and silica which can be reuse such as for geopolymer material. Silica and alumina are among typical metal that use in catalyst production.

1.3 Problem Statement

Although pyrolysis to convert waste to fuel has been done by several researchers, the main obstacle to commercial this technology is due to low yield and low product fuel quality. The application of the screw kiln reactor process with the presence of oxygen resulted to produce fuel that rich in alcohol (Serrano et al., 2003). In comparison to commercial fuel quality which rich in aromatics, implementation of catalyst like zeolite and alumina is necessary. It is reported that zeolite, ZSM-5 catalyst effectively improves pyrolysis process in term of fuel quality and the yield of the fuel produce (Miskolczi et al., 2009). Zeolite catalyst is quite expensive. It is not economical for mass production. Therefore, the application of oil palm ash waste that rich in carbon minerals (Iwuagwu and Ugwuanyi, 2014) has huge potential to be use as a catalyst and produce better fuel quality and yield. This also improves environment conservation as well as municipal waste and agricultural waste management. In this investigation, a pyrolysis of plastic waste to fuel by using catalyst that derived from oil palm ash is carried out.

1.4 Objectives

The objective of this study is to investigate the influence of real waste plastic composition in the catalytic pyrolysis to fuel by using oil palm biomass ash catalyst.

1.5 Scopes of Study

The following are the scope of this research:

1) The thermal decomposition of plastic waste was done by using Thermal Gravimetric analyser.
2) The catalyst was prepared by calcining the catalyst at 750 °C for four hours.
3) The experiment of pyrolysis of plastics waste to fuels was set up to test the catalyst performance at 450°C for 30 minutes.
4) The gas product composition was determined via GC-TCD. The catalyst was analyzed before the experiments via SEM and BET. The effect of plastic composition on product yield was studied by varying the plastic waste source

including shampoo plastic bottle, plastic bag and polystyrene food container and the mixture of the plastic sources.

5) The analysis of liquid product and characteristics was determined by various analyses in comparison to commercial product.

CHAPTER 2

LITERATURE REVIEW

2.1 Plastics and pyrolysis

Plastic is major components in municipal waste. The abundant amount of plastic waste is due to is massive application in human daily life especially in packaging services. Thus, converting plastic to valuable product is necessary, as plastics decomposition will take for ages. Converting plastics to energy like liquid fuel via pyrolysis interest many researchers recently. Pyrolysis is a thermal cracking process to either gas, solid or liquid product without oxidant. The main factors that effecting the pyrolysis of plastic is the type of plastic, cracking temperature, heating rate, operation pressure, reactor type, residence time and the application of catalyst.

2.2 Type of plastic

The pyrolysis products are related to the chemical composition and chemical structure of the plastics to be pyrolyzed. Plastics can be classified based on its structural shape of polymer molecules, as linear, branched, or cross-linked as illustrated in Figure 2.1.

There is a significant relationship between the density and the branching intensity of polymers. For HDPE and LDPE polymers both of them have the same chemical formula which is $–(CH_2\text{-}CH_2)_n–$, what differentiate them is, branched polyethylene is also called low density polyethylene (LDPE) which is different from linear polyethylene that is called high density polyethylene (HDPE) (Chanda, 2000). The PE with more branches has relatively lower density (McMurry, 2000).

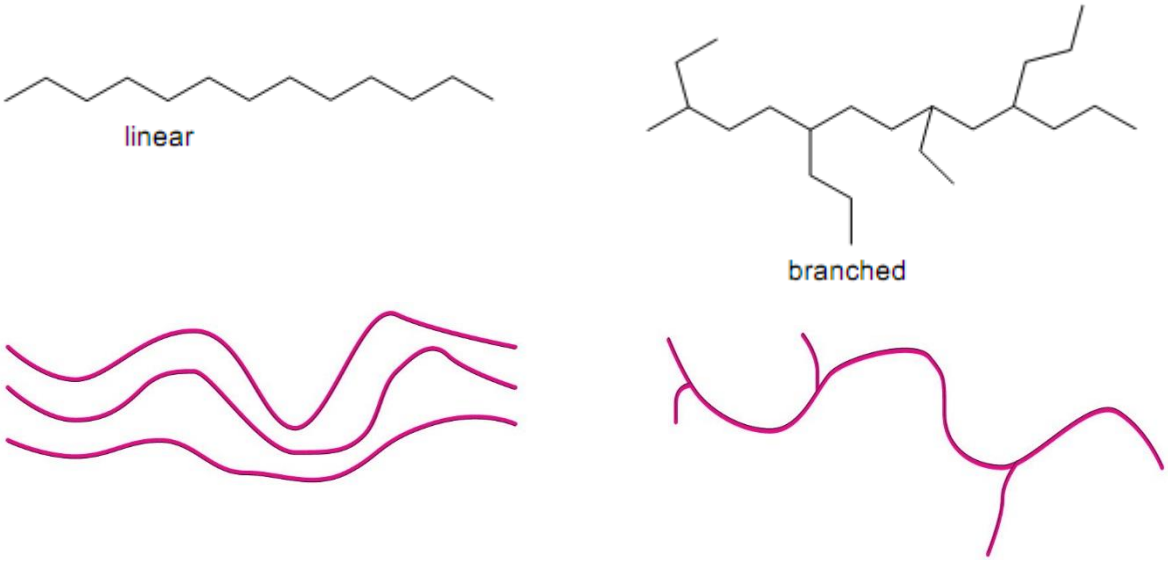

Figure 2.1: Polymer structure, linear and branched

For LDPE polymer there are about 20 branches per 1000 carbon atoms. The relative molecular mass, and the branching, influence the physical properties of LDPE. The branching affects the degree of crystallinity which in turn affects the density of the material. LDPE is generally amorphous and transparent with about 50% crystallinity. The branches prevent the molecules fitting closely together and so it has low density (McMurry, 2000).

The HDPE molecules can fit closer together. This leads to strong intermolecular bonds, making the material stronger, denser and more rigid than LDPE. The polymer is not transparent (McMurry, 2000).

For polystyrene (PS) it is called linear polymer although it contains functional groups as part of the monomer structure (Figure 2.2). The chemical formula of PS is $–[CH_2\text{-}CH(C_6H_5)]_n–$. In branched polymers, at least one of the monomers is connected to more than two functional groups due to the branching points produced from the polymerization process. The functional side group and the branch structure have significant effects on the pyrolysis product. For example, the dominant component in PS pyrolysis products is styrene that is the side group come off from PS carbon backbone. (Karaduman et al., 2001) (Arandes et al., 2003).

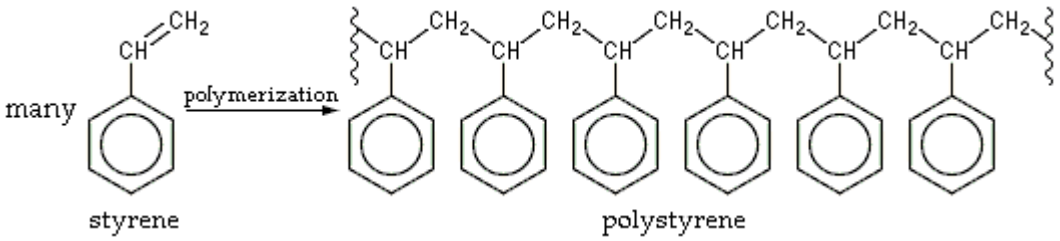

Figure 2.2: Polystyrene chemical structure

2.3 Cracking Temperature and Heating rate

Temperature is one of the most important operating variable, since the temperature dominates the cracking reaction of the polymer materials (Aboulkas et al., 2012).

It is known that pyrolysis temperature plays an important role on product distribution. As material reaches elevated temperatures, the different chemical components undergo thermal degradation that affects the conversion yield and product quality. Aboulkas *et al*. (2012) reported that the increase of the pyrolysis temperature from 400 to 500 – 520 °C caused a significant increase in the oil and gas yields as shown in table 2.2.1. This result was attributed to gas phase cracking reactions to yield increased hydrocarbons. At low temperatures, ≤400 °C, oil yields are reduced because of the coking reactions of the oil via conversion of the liquid oil to solid product and/or incomplete pyrolysis. There is consequently an optimum temperature where maximum oil yields are obtained.

The major effect of temperature reflects as a change in the yield of gaseous products: as temperature increases, the amounts of gaseous products increase which results as an increase in aliphatic hydrocarbon recovery (Aboulkas et al., 2012). Many studies have shown that temperature has a significant effect on yield and composition of pyrolysis products of polyethylene and polypropylene in a fluidized bed reactor or fixed bed (Aguando et al., 2006; Bagri, & Williams, 2002; Lee, 2006). It has been observed for most of the works that the oil yield increases as the temperature rises and the maximum oil yield produces at 500–550 °C. It is claimed that relatively low pyrolysis temperatures (around 400 °C) favors solid residue formation. Temperatures up to 500–525 °C maximize the production of oils and temperatures above 600 °C maximize gaseous products while minimizing solid residue formation.

Different locations of the temperature sensors in different studies are believed to be one of the most important factors on the different cracking temperature reported (Karaduman et al., 2001). Table 2.1 shows the effect of temperature on the product yield from the pyrolysis of plastics.

Table 2.1: Influence of temperature on the product yield from the pyrolysis of plastics (Aboulkas et al., 2012)

Type of plastic	**Heating rate (°C)**	**400**	**450**	**500**	**525**	**550**	**600**
HDPE	Conversion	93.9	95	99.3	99.6	99.7	99.7
	Oil	85	85.6	88.3	86.1	84.2	82.1
	Gas	8.9	9.4	11	11.7	13.4	16
	Char	6.1	5	0.7	0.4	0.3	0.3
LDPE	Conversion	94.1	95.2	99.5	99.6	99.7	99.7
	Oil	87.2	87.9	89.6	88.6	86.6	84.2
	Gas	6.9	7.3	9.9	11	13.1	15.5
	Char	5.9	4.8	0.5	0.4	0.3	0.3

Aboulkas et al., (2012) reported that as the heating rate increases, the conversion degree and the yield of gases increase and the yields of oils and char decrease when HDPE and LDPE plastic was pyrolysed. In this work, increasing the heating rate higher than 10 °C min^{-1}, from 10 to 20 °C min^{-1}, caused a slight decrease of 0.8 wt.% in the oil yield as shown in Table 2.2. This slight decrease in the oil yield may be attributed to no more effect of the heating rate on the self-generated (autogenous) gas sweep pyrolysis.

Williams & Williams (1998) suggest that the pyrolysis process may be a diffusion-limited process controlled by heat and product diffusion. They suggest that the extent of diffusion control increases at high heating rates because products are generated faster than they can diffuse out of the pores, consequently secondary coking reactions

will occur. The extent of diffusion control diminishes during the course of the reaction as the shale changes from impervious rock to porous ash as the pyrolysis products leave the matrix. Table 2.2 shows the effect of heating rate on the product yield from the pyrolysis of plastics.

Table 2.2: Influence of heating rate on the product yield from the pyrolysis of plastics (Aboulkas et al., 2012)

`	**Heating rate (°C/min)**	**2**	**5**	**10**	**15**	**20**
HDPE	Conversion	97.3	98.4	99.3	99.4	99.6
	Oil	88.6	88.5	88.3	87.8	87.4
	Gas	8.7	9.9	11	11.6	12.2
	Char	2.7	1.6	0.7	0.6	0.4
LDPE	Conversion	97.4	98.9	99.5	99.6	99.7
	Oil	89.9	89.8	89.6	88.7	88.3
	Gas	7.5	9.1	9.9	10.9	11.4
	Char	2.6	1.1	0.5	0.4	0.3

2.4 Type of reactor

In the batch reactor, the materials are fed into the reactor in batches for pyrolysis either at the start of the process or after all of the fed materials are processed. In Onwudili et al., (2009) works, a 300 mL Parr Mini Bench Top Reactor, Type 4561m stirred pressure reactor made of T 316 stainless steel was used. The reactor was heated using an external mantle type furnace, which contacted the sides and bottom of the reaction vessel. A J thermocouples was use and increment of 10°C of the heating rate. Nitrogen gas was used as reaction atmosphere for all experiments to ensure inert pyrolysis condition. Each experiment was carried out with an initial nitrogen pressure of 0.3 MPa. About 10 g of sample was used in each experiment. A set of experiments was carried out for 1 h each between 350 and 500 °C. After the reactor had cooled, three

samples of gas product were carefully taken for gas chromatography analysis. The remaining gas was then discharged, the reactor opened and the vessel weighed to determine then weight of liquid and char products. The char was then separated from the oil by filtration and weighed. Finally, oil from the reactor vessel was transferred into amber glass bottles and placed in a refrigerator until further analysis. The setup of the experiment as shown in figure 2.3.

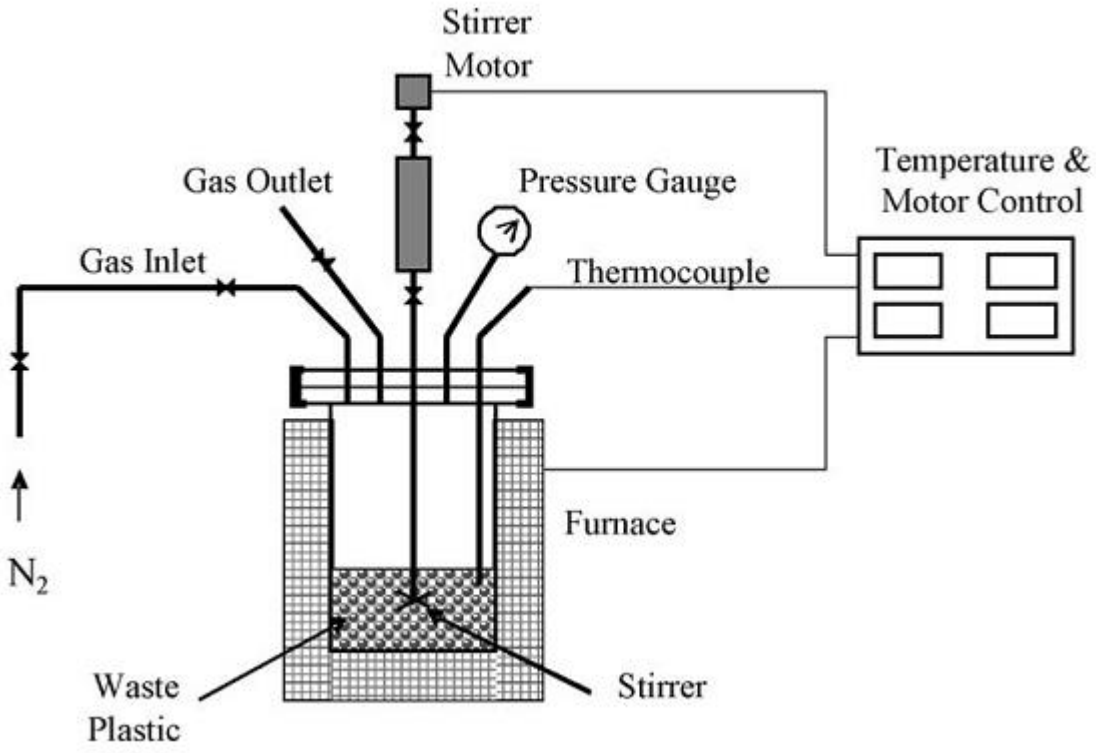

Figure 2.3: Experiment setup for closed batch reactor (Onwudili et al., 2009)

A semi-batch reactor removes the pyrolysis products continuously once they are generated but the feed materials are added initially before the pyrolysis process starts. Some semi-batch process uses inert carrier gas to help remove the pyrolysis products. Kumar and Singh, (2011) use a semi batch reactor is use and is made of stainless steel tube (length-145 mm, internal diameter-37 mm and outer diameter-41 mm) sealed at one end and an outlet tube at other end as shown in Figure 2.4. The reactor is heated externally by an electric furnace, with the temperature being measured by a Cr-Al: K type thermocouple fixed inside the reactor, and temperature is controlled by an external PID controller. About 20g of waste plastics sample were loaded in each pyrolysis reaction. The condensable liquid products/wax were collected through the condenser

and weighed. After pyrolysis, the solid residue left inside the reactor was weighed. Then the weight of gaseous/volatile product was calculated from the material balance. Reactions were carried out at different temperatures ranging from 400-550°C.

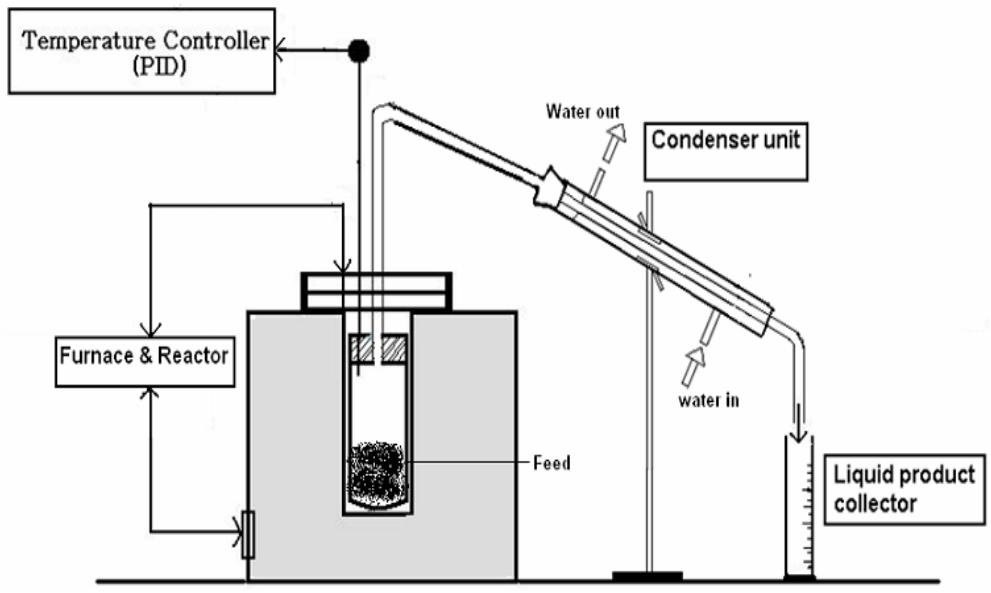

Figure 2.4: Semi-batch reactor pyrolysis process setup (Kumar and Singh, 2011)

In the continuous reactor, the feed materials are input from one part and the products are led out from the other part of the reactor. According to Li et al., (2004) research, a continuous rotary kiln reactor was use for the pyrolysis of scrap tires. The reactor consisted of a pyrolytic rotary kiln main reactor and peripheral systems including a supply system (a storage bin with a screw feeder), a tar condenser and reservoir, a solid residue collection tank, a flue gas cleaner, a demister filter, a gas burner, and an effluent gas sampling system as shown in Figure 2.5.

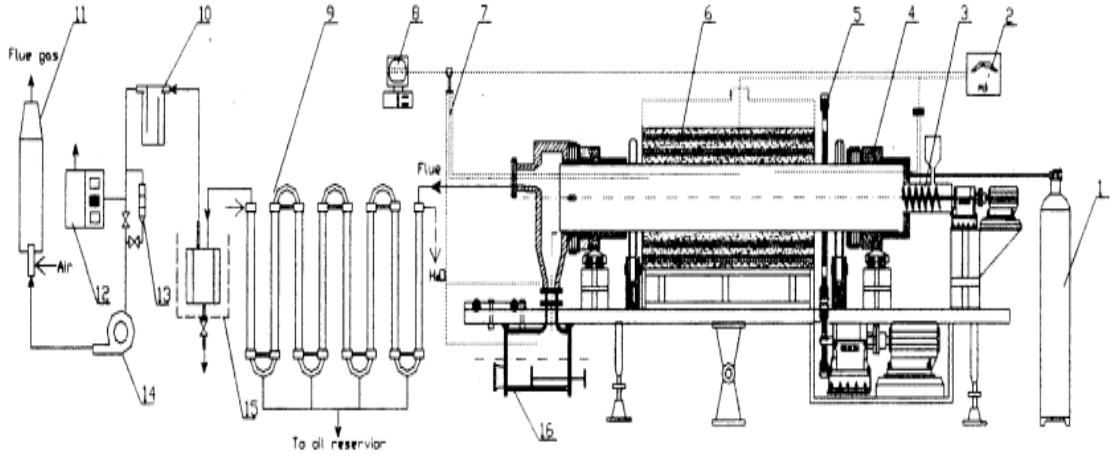

Figure 2.5: Schematic of pilot-scale rotary kiln pyrolysis reactor (Li et al., (2004)

The kiln was designed for continuous operation with tire powder conveyed from a sealed container to the electrically heated rotary kiln by a screw feeder. The feeding rate was regulated from 10 to 30 kg/h. The kiln diameter was 0.3 m, and the overall length was 3.0 m. The effective heated length of the kiln was about 1.8 m. The solids were transported in the kiln as a result of inclination and rotation. At the kiln exit, the residue char fell into a sealed 6 L container. The evolved oil vapors and gases were quickly removed from the reactor by a special induced fan to reduce the residence time. The condenser, with four coils cooled by water and a trap refrigerated by ice, was used to recover pyrolytic oils into the reservoirs. The non-condensable gases passed to the scrubbing unit to remove the acids and finally passed to the burner.

2.5 Residence time

In fast pyrolysis or continuous pyrolysis process, it refers to the contact time of the plastic on the hot surface throughout the reactor. However, in slow pyrolysis and batch process, the residence time means the duration from the time when feedstock plastic start to be heated to the time when the products are removed. Longer residence time favors a further conversion of the primary products thus yielding more thermal stable products such as light molecular weight hydrocarbons, non-condensable petroleum gases. (Miller et al., 2005; Hernández et al., 2006). In a slow pyrolysis, long residence time encourages the carbonization process and produces more tar and char in

the products. (Buekens, A. 2006). Table 2.3 shows the relationship of the type of pyrolysis process with the target products produce in the pyrolysis process.

Table 2.3: Pyrolysis processes and target products (Jung and Fontana 2006)

Process	**Heating rate**	**Residence time**	**Temperature °C**	**Target Products**
Slow carbonization	Very low	days	450 - 600	Charcoal
Slow pyrolysis	10 -100K/min	10 – 60 min	450 – 600	Gas, oil, char
Fast pyrolysis	Up to 1000K/s	0.5 – 5 s	550 – 650	Gas, oil, char
Flash pyrolysis	Up to 10000K/s	<1 s	450 - 900	Gas, oil, char

In the López et al., (2011) studies, the effect of time versus the product yield was conducted. A 3.5 dm^3 semi batch reactor was use at atmospheric pressure with a nitrogen purging at 50 ml/min. The temperature for pyrolysis process was at 500°C with a heating rate of 20°/min. The plastic use was polyethylene and the experiment was conducted for 2 hours to see the effect of time towards product yield as shown in Figure 2.6. It shows that the optimum time for pyrolysis of polyethylene at 500°C is between 25 – 50 min. This is because after 50 minutes, there is less different in the product yield especially for the liquid product yield. If the experiment were conducted longer than 50 minutes, it means that a higher energy consumption which related to cost loss as the product yield does not have a significant change.

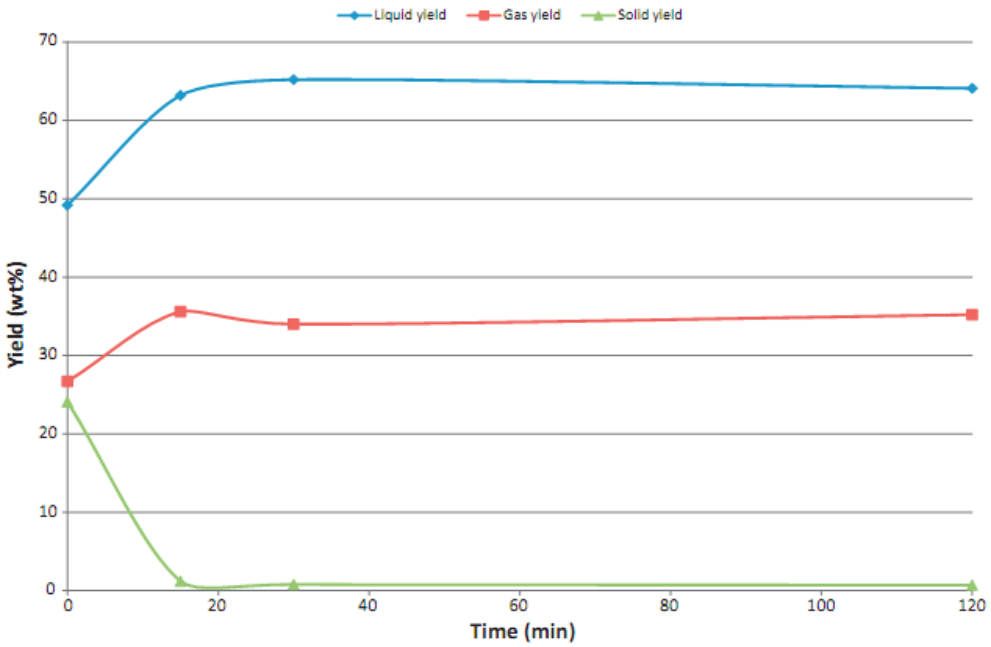

Figure 2.6: Pyrolysis yield (wt%) as a function of time at 500°C (López et al., 2011)

2.6 Catalyst

Catalysts are used in most cases to modify the structure of products and decrease the energy consumption. However, the addition of the catalyst can be troublesome, e.g. the catalyst might be accumulated in the residue or coke (Williams and Williams, 1997). Generally used catalysts for pyrolysis of plastic wastes are mordenite, fluid catalytic cracking (FCC, ZSM-5, etc., but the ZSM-5 and FCC catalysts provided the best possibility to yield hydrocarbons in the boiling range of gasoline. On the other hand, the structure of zeolite and its pore size fundamentally determine the cracking property of the catalyst Not only the structure of products, but also their yields can be considerably modified by catalysts. (Williams and Williams, 1997; Zadgaonkar, 2006; Masuda and Tago, 2006).

The presence of catalyst reduced the liquid fraction and increased the gaseous fraction. Theoretically, the catalyst can enhance the cracking reaction of the pyrolysis gas. Long chain hydrocarbons have been cracked into lighter hydrocarbon gases. Syamsiro et al., (2014) reported that pyrolysis over natural zeolite catalyst produced higher liquid product compared with Y zeolite catalyst. This is due to different activity

between natural zeolite and Y zeolite. Natural zeolite has lower BET surface area than that of Y zeolite. Higher surface area will give more contact between catalyst and pyrolysis gas which means more gas will be cracked to produce shorter chain hydrocarbons.

However, the presence of catalysts has slightly effect to the product yields. The impurity which contains some toxic materials will deactivate the catalysts. Thus, the catalysts will have the activity in the beginning of the reforming process and deactivate in the end of the process. (Syamsiro et al., 2014). Figure 2.7 shows the effect of different types of feedstocks on the product yield and the liquid fraction composition

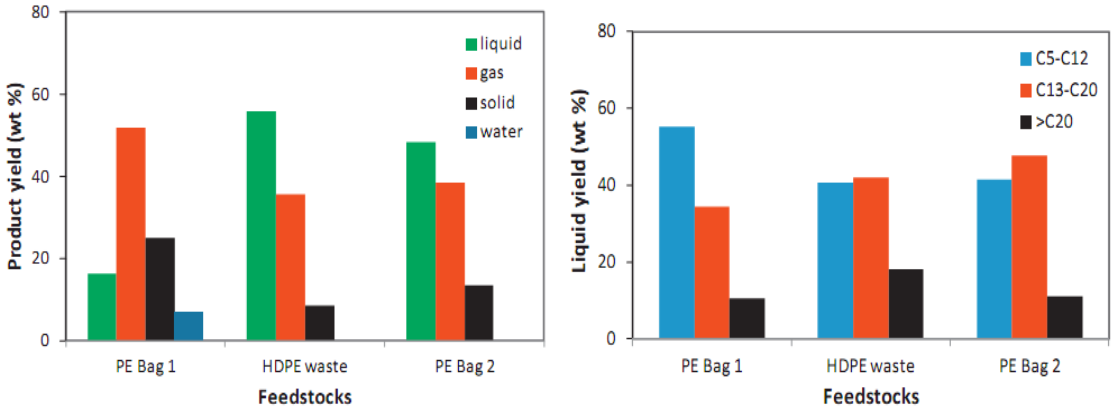

Figure 2.7: Effect of different types of feedstocks on (a) the product yields; and (b) the liquid fraction composition (Syamsiro et al., 2014).

2.6.1 Zeolite properties: pore size (structure) and Si/Al ratio (acidity)

Zeolites are crystalline micro-porous aluminosilicates. Therefore, Si/Al ratio is also an important parameter for zeolites which is applied to classify the zeolites (Barrer, R.M 1985). The high-silica zeolites, with a Si/Al ratio greater than five such as ZSM-5, are widely used in petrochemical industries (Maesen, T. 2007). These zeolites are preferred for polyolefin cracking. Lower Si/Al ratio implies lower acidity and smaller crystal size of zeolite provide higher efficiency in terms of conversion

2.6.2 Palm oil mill ash properties

The solid waste from palm oil mill industry has been increasing annually where it has been reported that the palm oil waste was produced 4 million tons/years in Malaysia only (Zarina et al., 2013). Hence, the solution to overcome the problems is to reuse the waste and produced new composites that are benefit. This ash contains silica (Si) which has potential to develop as geopolymer composites (Zarina et al., 2013). Palm oil fuel ash is rich in SiO_2 as tabulated in table 2.4 which is believed that it can be used as a catalyst for pyrolysis of plastic to replace ZSM-5.

Table 2.4: Chemical composition of Palm Oil Mill Ash (Johari et al., 2012)

Chemical Component	Palm Ash Composition, Malaysia (wt%)
SiO_2	51.18
Al_2O_3	4.61
Fe_2O_3	3.42
CaO	6.93
MgO	4.02
SO_3	0.36
K_2O	5.52
Na_2O	0.06
Loi (Loss of ignition)	21.6

The high silica content in the catalyst makes the framework to stand high temperatures that this type catalyst is suitable for high temperature pyrolysis and regeneration cycle (Maesen, T. 2007). Figure 2.8 shows the original palm oil mill ash.

Figure 2.8: Original Palm Oil Mill Ash

Megat Johari et al., (2012) have done a research on how to improve the POMA with a certain treatment. Firstly, to remove the coarse particles such as fiber and kernel which are incomplete burned, the POMA was dried in oven at temperature 105 ± 5°C for 24 hours and then sieved passing through 300 in sieve. The following step was ground the POFA to achieve more fine particles and then heated again in furnace at temperature 500 ± 5°C for 90 minutes to remove unburned carbon and increase the pozzolanic properties. The research shows that the treated POFA will have a significant increase in SiO_2 which is prefer to become the catalyst for pyrolysis of plastic. Table 2.5 summarizes the chemical composition of ground and treated POMA.

Table 2.5: Chemical composition of treated POMA (Megat Johari et al., 2012

Chemical Component	**Ground POMA (wt%)**	**Treated POMA (wt%)**
SiO_2	51.18	65.01
Al_2O_3	4.61	5.72
Fe_2O_3	3.42	4.41
CaO	6.93	8.19
MgO	4.02	4.58
SO_3	0.36	0.33
K_2O	5.52	6.48
Na_2O	0.06	0.07
C	19.05	0.09
LOl	21.6	2.53

2.7 Pressure

Operating pressure has significantly effect on both the pyrolysis process and the products. The boiling points of the pyrolysis products are increased under higher pressure, therefore, under pressurised environment heavy hydrocarbons are further pyrolyzed instead of vaporized at given operation temperature (Miranda et al., 2001). Figure 2.9 shows the effect of pressure on hydrocarbon number and their fractions in the pyrolysis products of PE. In effect, under pressurized pyrolysis, more energy is required for further hydrocarbon cracking. It was also found that high pressure increases the yield of non-condensable gases and decreases the yield of liquid products. (Figure 2.10) The average molecular weight of gas product also decreases with the increase of pressure (Sato and Sakata, 2004).

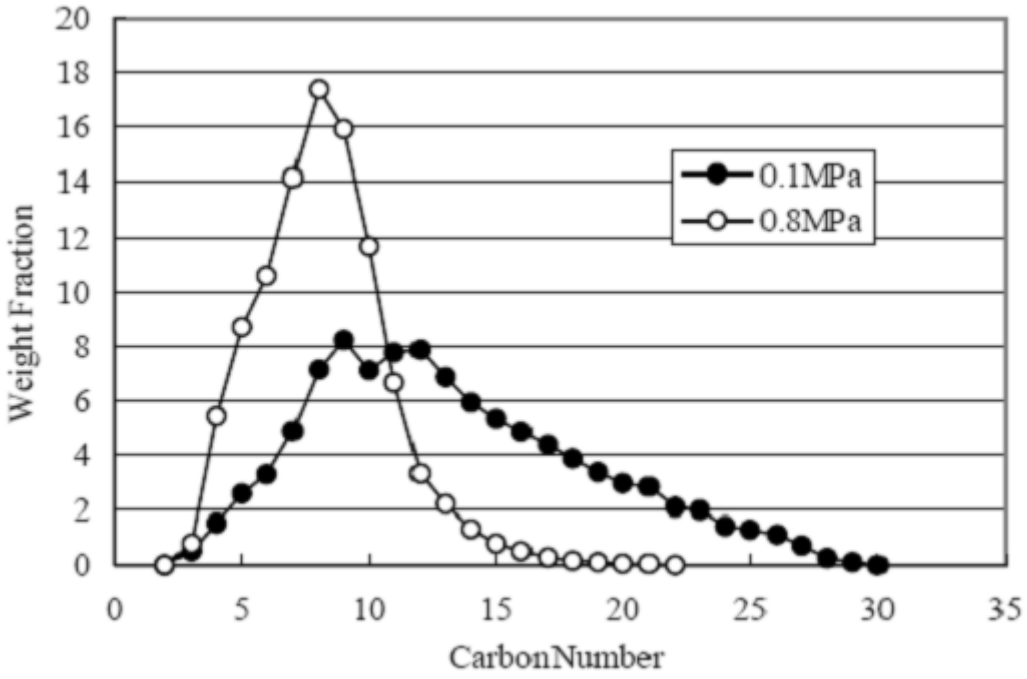

Figure 2.9: Effect of pressure on the distribution of PE pyrolysis product

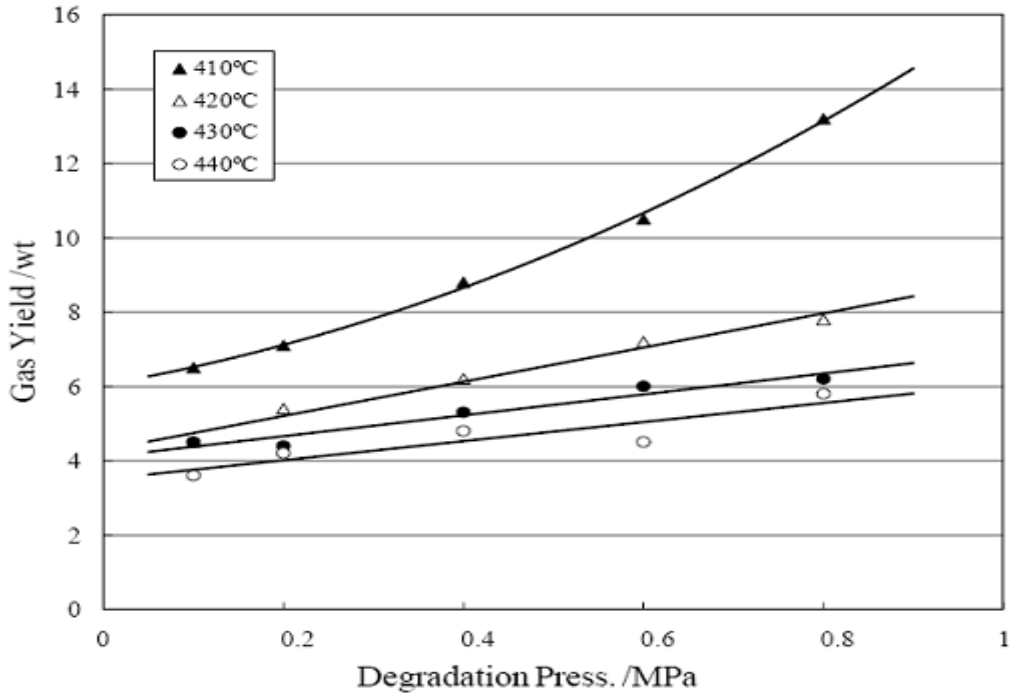

Figure 2.10: Effect of pressure on the yield of gas at different temperature (Sato and Sakata, 2004)

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter describes detail description on material, catalyst preparation, sample preparation and testing method of the sample in catalytic pyrolysis of real samples wastes. The catalyst was tested with various type of samples including shampoo bottle, polystyrene and sample composition by mixing the samples at various weight ratio. The mixing composition is based on the real plastic composition in municipal waste.

3.2 Materials

The samples waste like shampoo bottle, plastic wrapper, plastic bag and polystyrene, were obtained at Kolej Kediaman 2 neighbourhood, Universiti Malaysia Pahang. Meanwhile, the oil palm ash was obtained from Lepar Palm Oil Mill, Kuantan, Malaysia. The nitrogen gas will be obtained from Malaysia Oxygen, MOX.

(a) (b) (c) (d)

Figure 3.1: (a) Shampoo bottle (b) Plastic bag (c) Plastic wrapper (d) Polystyrene

3.3 Apparatus

Laboratory apparatus that was used are heating mantle, one-liter borosilicate flask, condenser, conical flask, thermocouple and stopwatch.

3.4 Plastics preparation

A shampoo bottle, plastic bag, plastic wrapper and polystyrene were used to represent HDPE, PP, LDPE and PS respectively. A mixture of 35% shampoo bottle, 35% plastic bag, 19% of plastic wrapper and 11% Polystyrene was also prepared. All samples were cleaned and cut into 0.5 – 1 cm pieces.

3.5 Plastics Characterization

The thermal decomposition behavior of the shampoo bottle (HDPE), plastic bag & plastic wrapper (LDPE), and polystyrene (PS) was analyzed at various temperatures via Thermogravimetric analyzer model TGA Q500 V6.7. About five mg of sample was placed in a platinum crucible. The sample was heated up to 890°C at a constant heating rate of 20 °C min^{-1} in a nitrogen atmosphere at 100 ml min^{-1}. The TGA equipment is shown in figure 3.2.

Figure 3.2: TGA equipment

3.6 Catalyst preparation

The palm oil mill ash was calcined at 750°C for four hours with the increment of 15°C.min^{-1}. The calcine ash was further filter using a sieve filter of size 125 μm. The catalyst was kept in a tightly seal container.

3.7 Catalyst Characterization

3.7.1 Catalyst pore structure

The BET surface analysis was used to measure the total specific surface area, pore size, and pore volume of the catalyst. The BET analysis was tested by Micromeritics ASAP 2020 Surface Area and Porosity Analyzer. BET analysis provides precise evaluation of materials by nitrogen multilayer adsorption measured as a function of relative pressure using a fully automated analyzer. In other word, the surface area was determined by adsorption of a monolayer of nitrogen molecules on the catalyst surface at the temperature of liquid nitrogen. The catalyst was degassed up to 200°C for six hours prior to analyze. The BET equipment is shown in figure 3.3.

Figure 3.3: BET equipment

3.7.2 Catalyst surface morphology

The fresh and spent catalysts surface topography was analyzed by using a high resolution SEM with an attachment with EDX by focusing electron beam over a surface to create an image. The electrons in the beam interact with the sample, producing various signals that can be used to obtain the information. The EDX technique used to identify the elemental composition of materials where the data generated by EDX analysis consist of spectra showing peaks corresponding to the elements making up the true composition of the sample being analyzed. Figure 3.4 shows the SEM with EDX equipment.

Figure 3.4: SEM with EDX equipment

3.8 Catalyst testing

The experiment setup is shown in Figure 3.7.1. The catalyst testing was carried out in the reactor rig consisted of round one-liter borosilicate flask, condenser, thermocouple, heating mantle, liquid collector and gas bag. A sample of including shampoo bottle, plastic wrapper, plastic bag and polystyrene was used. A mixture of 35% shampoo bottle, 35% plastic bag, 19% of plastic wrapper and 11% Polystyrene was also applied. The feed which consisted of plastic to catalyst at weight ratio of 10:1 was tested at 450°C for 30 minutes. Nitrogen, N_2 at 50 $ml.min^{-1}$ was used to purge oxidant to provide oxygen free environment and transport all the gases through the

reactor. The vapor was passed through condenser. The liquid product was collected in a conical flask at the end of the condenser. The uncondensed gases were collected in a gas bag.

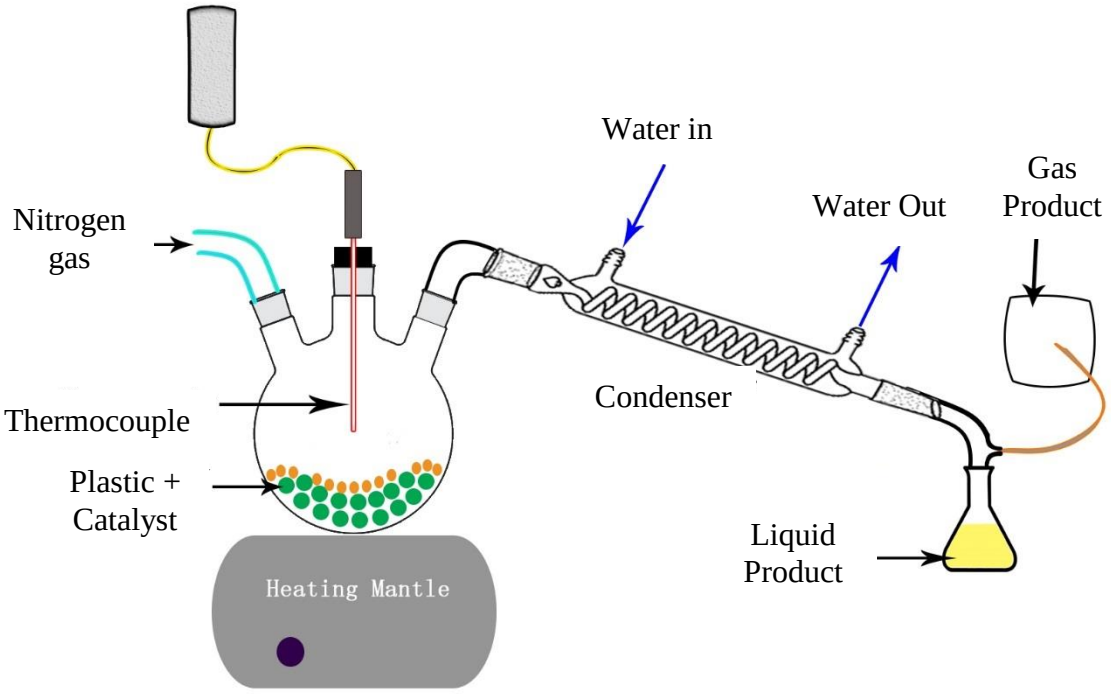

Figure 3.5: Experiment setup

3.9 Gas product Analysis

An Agilent 6890N Gas Chromatograph Thermal Conductivity Detectors (GC-TCD) that equipped with Haysep packed column was used to determine the compound of gas. The column oven was set at 50°C with Helium as the carrier gas flow at 10ml.min^{-1}. Figure 3.6 shows the GC-TCD equipment.

Figure 3.6: Gas Chromatograph Thermal Conductivity Detectors (GC-TCD)

3.10 Liquid product analysis

3.10.1 Product yield calculation

Product yield was determined after the experiment by calculating the mass difference of the apparatus before and after the experiment. The apparatus involved such as conical flask (liquid product), condenser (wax product), rotary flask (solid product). The gas product was determined by calculating the overall mass differences. The yield for the product is calculated using eq 3.1.

$$Mass\ In = Mass\ Out$$

$$Sample\ Plastic\ + Catalyst = Liquid\ + Solid\ + Wax + Gas$$

The yield percentages were determined by using the following equation,

$$Yield\ (\%) = \frac{Mass\ Liquid\ (g)}{Mass\ Total\ (g)} \times 100\% \qquad \textbf{eq 3.1}$$

3.10.2 Liquid composition

The liquid product was diluted to 10 fold with dichloromethane (DCM) A Agilent 5975C inert MSD Mass Spectrometry gas chromatography (GCMS) was used. The GC was equipped with DB1 capillary column. The detector and front inlet oven was set at 230 °C and 250 °C respectively. Figure 3.7 shows the GCMS equipment.

Figure 3.7: GCMS equipment

3.10.3 Calorific value

An oxygen bomb 1341 Parr calorimeter that equipped with 6775 Digital Thermometer was applied. About one ml of liquid fuel and 10 cm of titanium fuse was used. The bomb calorimeter was filled up with oxygen and fuse was ignited. Data was recorded for every minute until constant temperature was achieved. Figure 3.8 shows the oxygen bomb 1341 Parr calorimeter.

Figure 3.8: Oxygen bomb 1341 Parr calorimeter.

Calculation was performed to calculate the calorific value by using following eq 3.2

$$Hg = \frac{(\Delta T)(w)-(2.3\times L)}{m} \qquad \textbf{eq 3.2}$$

Where:-

w is constant 2409.26 cal/°C

ΔT is T_{final}-$T_{initial}$ (°C)

L is length of fuse wire burn/consume (cm)

m is mass of sample use (gram)

3.10.4 Cetane and Octane number

The octane and cetane number of the liquid fuel was determined by using portable analyser of Octane Tester SX-200. The analyser was able to measure octane number of gasoline (RON, Research Octane Number), cetane number of diesel fuel, estimation of diesel fuel freezing temperature, purity level, and quality of motor, industrial and transformer (dielectric puncture potential) oil, Motor Octane Number (MON) and antiknock index (AKI (RON+MON)/2) simultaneously

3.11 Density, clarity, moisture content and viscosity

3.11.1 Density

Density was determined by weighting one ml of liquid sample on the analytical weight plate.

3.11.2 Clarity

Clarity is used to determine the extent to which light is either absorbed or scattered by suspended material in liquid fuel. A 2100P Portable Turbidimeter was used. Direct digital readout in NTU (nephelometry turbidity units). The clarity data in a range of 0 to 1000 NTU was achieved

3.11.3 Moisture

A Metrohm 787 KF Titrino with 703 Ti stand (Figure 3.9) was used to analyze moisture content. The Hydranal-Composite 5 reagent and Methanol dryer was used. Methanol dryer was pumped into titration vessel and stirring speed was controlled. Moisture was obtained by determining the volume of reagent and dryer.

Figure 3.9: Moisture analysis equipment.

3.11.4 Viscosity

The viscosity and kinematic viscosity of the liquid fuel was determined by using Cole Parmer Viscosity bath EW-98928-30 as shown in figure 3.10.

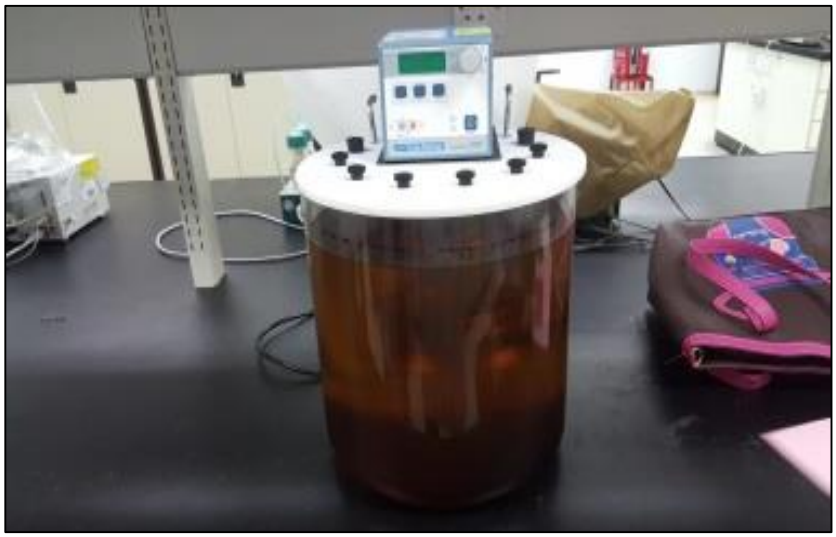

Figure 3.10: Viscosity and kinematic viscosity analysis equipment

The liquid fuel viscosity is in unit of centipoise (cP). Viscosity value was determined by using eq 3.3 and eq 3.4

$$Kinematic\ Viscosity\ \left(\frac{mm^2}{s}\right) = Time\ (s) \times Viscometer\ Constant\ \left(\frac{mm^2}{s^2}\right) \qquad \textbf{eq 3.3}$$

Where: Viscometer Constant (150L) = 0.033320 mm^2/s^2

$$Viscosity,\ mPs.s\ (cP) = Kinematic\ Viscosity\ \left(\frac{mm^2}{s}\right) \times Density\ \left(\frac{g}{ml}\right)$$ **eq 3.4**

The viscometer constant according to the Canon-fenske size is shown in table 3.1

Table 3.1: Viscometer Constant

Canon-fenske size	**Viscometer Constant (mm2/s2)**
25	0.002117
100	0.01512
150	0.03332
200	0.1098
350	0.4899
450	2.374

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

In this chapter, the experimental data and results are tabulated and discussed. This chapter begins by discussing the plastic characterization via TGA for shampoo bottle plastic waste. The characterization of the catalyst is also discussed thoroughly. The outcome of the catalyst testing including the product yield and the product properties are elaborated in this chapter too. The comparable of product to commercial fuel is also briefly done.

4.2 Plastics characterization

The thermogravimetric (TG) of shampoo bottle was carried out in nitrogen gas atmosphere. The thermogravimetric curve of shampoo bottle is presented in Figure 4.1. The detailed TGA analysis is in appendix A. As the evident from the figure 4.1, the degradation behaviors of shampoo bottle in the temperature between 430 - 520° C. It also indicates that almost 96 wt% of the shampoo bottle decomposed. Shampoo bottle is originally made from virgin HDPE pellet.

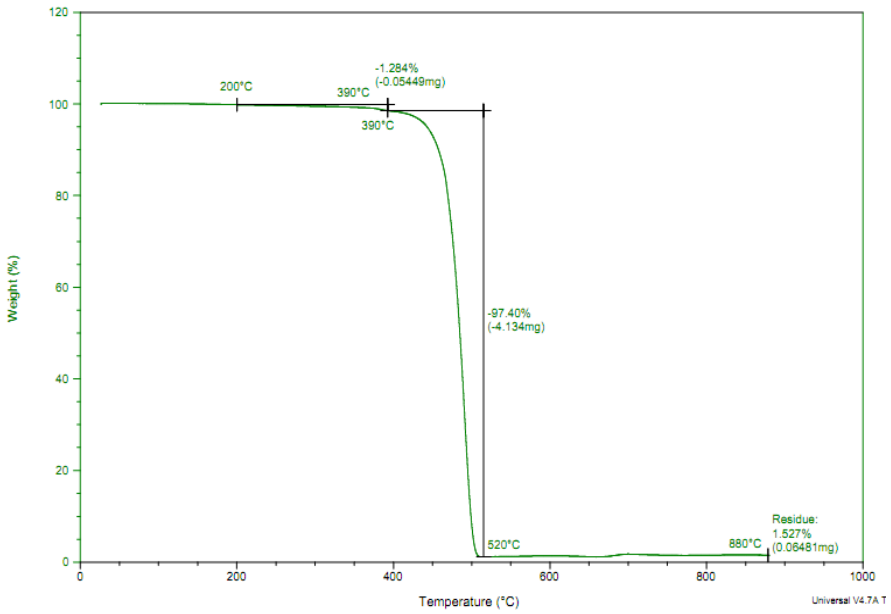

Figure 4.1: TGA Thermograms for shampoo bottle

The thermal degradation of the virgin HDPE is 420 - 490° C (Ali and Qureshi 2011) which is quite similar with the shampoo bottle. It is believed that the reason why is there a slightly different in the final degradation temperature in the shampoo bottle because it has been added some additive to the plastic such as anti-oxidant, fillers, fire retardant and so on. Mineral flame retardant such as aluminum hydroxide and magnesium hydroxide mainly act as an additive which do not chemically attached to the surrounding system. The use of hydroxides is limited by their relatively low decomposition temperature which limits the maximum processing temperature of the polymers. This might also happen to other real waste plastic types like polystyrene (PS), plastic bag (PP) and plastic wrapper (LDPE) who share the same degradation profile. PP, PS and LDPE are reported to degrade at 430 – 500 °C, 380 – 450 °C and 400 – 500 °C respectively (Ali and Qureshi, 2011) as shown in figure 4.2.

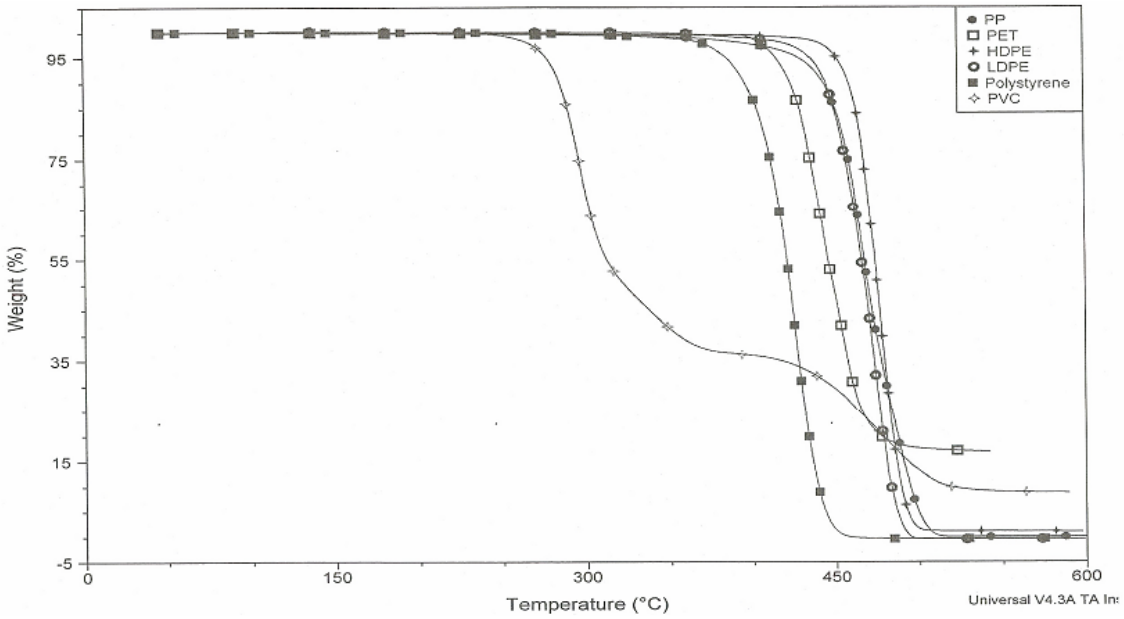

Figure 4.2: TGA thermograms for virgin plastics (Ali & Qureshi 2011)

4.3 Catalyst Characterization

4.3.1 Catalyst pore structure

For the BET analysis the surface area, pore size and pore volume of the catalyst was known. In this study the capability of adsorption and desorption of ash catalyst was determined. The result for the surface area, pore size and pore volume of the catalyst is tabulated in table 4.1. The raw data for the analysis is in appendix C.

Table 4.1: BET ash catalyst

	Surface area (m^2/g)	**Pore size (A)**	**Pore volume (cm^3/g)**
Catalyst	0.695	316.962	0.005506

It can be seen in Table 4.1 that the catalyst pore size is between 2 nm -50 nm. Thus, it is a mesoporous catalyst. Park et al. (2010) carried out investigation on Mesoporous ZSM-5 in pyrolysis of biomass. They reported that the mesoporous ZSM-5 catalyst promote the coke formation faster than conventional ZSM-5 catalysts. The presence of mesoporosity allowed for the formation of larger aromatics which were able to polymerize into coke and at higher temperatures these larger aromatics are more volatile and able to diffuse out of the mesopores of the sample (Foster et al., 2012).

4.3.2 Catalyst surface morphology

The generated SEM micrographs and EDX analysis for fresh calcined ash catalyst at different focal focus ranging from 1K-5K are shown in figure 4.4.

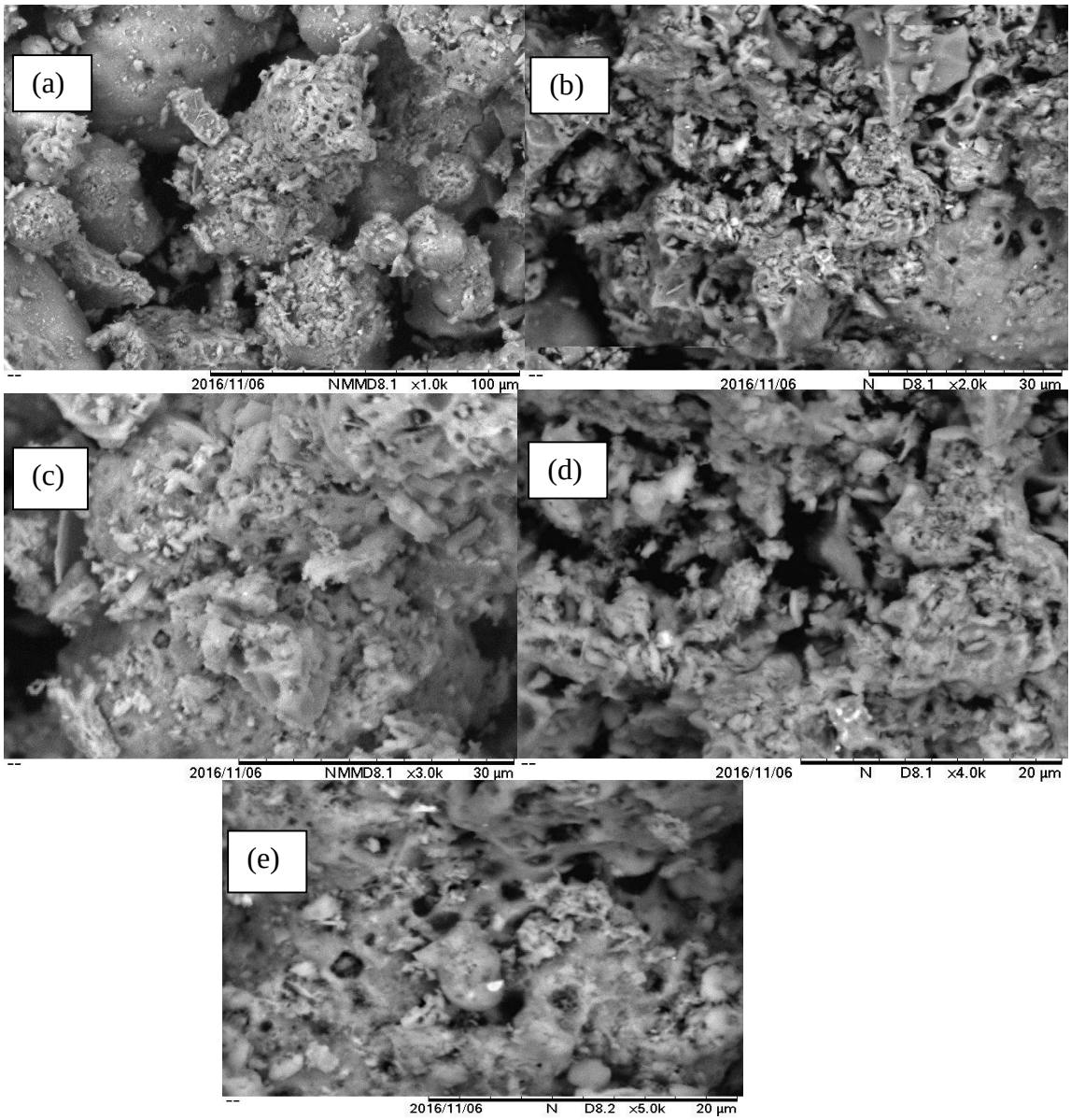

Figure 4.3: (a) Calcine ash catalyst 1K focus (b) Calcine ash catalyst 2K focus (c) Calcined ash catalyst 3K focus (d) Calcined ash catalyst 4K focus (e) Calcined ash catalyst 5K focus

Form the figure 4.3, it shows the catalyst has almost smooth surface area. Pores on the catalyst surface can also be observed in figure 4.3. In higher resolution catalyst image, large pore structure clearly can be observed distributed on the catalyst surface. It

is a proof that the catalyst has mesoporous structure. The detailed SEM with EDX result is in appendix B

For the ash catalyst EDX analysis testing, the result is show in figure 4.4 and table 4.2.

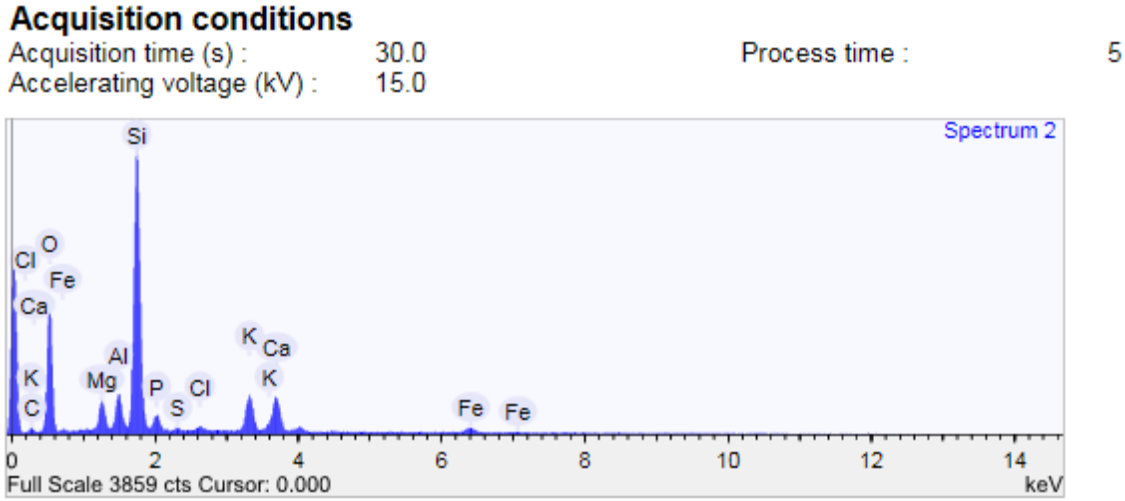

Figure 4.4: Elemental EDX analysis for calcined ash catalyst

Table 4.2: Summary result for ash catalyst for EDX analysis.

Element	Weight%	Atomic%
Carbon	5.134	8.557
Oxygen	49.784	62.291
Magnesium	2.701	2.224
Aluminium	2.817	2.090
Silicon	23.508	16.755
Phosphorus	1.910	1.234
Sulphur	0.334	0.209
Chlorine	0.502	0.284
Potassium	5.371	2.750
Calcium	5.399	2.696
Iron	2.540	0.911

Table 4.2 indicates that the calcined ash catalyst has minerals like Mg, Si, Al, Fe, K and Ca that typically use as a catalyst. The calcined ash catalyst has high

composition of oxygen (62%). This amount might be attributed by the oxygen content in metal oxide. Silicon also gives a high weight percent compare to other element. Carlson & Adriano, (1993) also reported the same observation.

4.4 Catalyst testing

In this study, the effect of real plastics waste is to determine using the calcined ash catalyst. The summarization of the yield% for each of the plastic waste is tabulated in table 4.3.

Table 4.3: Yield% for individual plastic waste

Types		Plastic Waste				
		Plastic Bag	**Shampoo Bottle**	**Plastic Wrapper**	**Polystyrene**	**Mixture**
Yield (%)	Liquid	33.81	50.73	27.47	71.19	48.08
	Solid	26.00	26.80	33.20	24.00	27.32
	Gas	37.20	21.88	38.54	4.02	21.2
	Wax	2.99	0.59	0.79	0.79	3.4

From table 4.3, it is known that the yield for liquid is highest for polystyrene compare to other plastic which is 71.19%. This finding is almost similar to Williams & Slaney, (2007) work. They found out that about 71% liquid, 2% gas and 27% solid product was produced in plastic pyrolysis at 500 ˚C with 5˚C $min^{-1}$for one hour in a batch reactor.

The shampoo bottle produced about 50.73% liquid, 26.8% solid and 21.88% of gas. According to Sharma et al., (2014), the catalytic pyrolysis of plastic grocery bag (HDPE), yield about 74% liquid, 17% solid and 9% gas. The experiment was conducted in a batch reactor at 440 ˚C for two hours. Shampoo bottle mostly made of unsaturated hydrocarbon in which it is bonded with either double or triple bond. Thus, it is believed that the hydrocarbon chain is hard to break because of the high strength and density.

For plastic bag and plastic wrapper, more gas was achieved. About 37% and 38% of gas produced in plastic bag and plastic wrapper respectively. Meanwhile, higher liquid product for plastic bag (33%) than plastic wrapper (27%) was obtained. For mixture of plastic wastes, it generates about 48.08% of liquid fuel, 21.2% of gas and 27.31% of solid.

4.5 Gas product Analysis

The composition of the gas product is tabulated in table 4.4. It can be seen that in table 4.4 that the composition (mol%) of methane was observed to be the highest for plastic bag (4.18 mol %) and plastic wrapper (3.5 mol %).. For shampoo bottle, it only contained about 2.52 mol% of methane. The detailed gas analysis via GC-TCD is in appendix D.

Polystyrene generated a low amount of methane gas which is 0.49 mol%. Williams & Bagri, (2004) also reported that their research on catalytic pyrolysis of fuel of PS pellet give a low value of methane gas composition which is 0.1wt%.

Table 4.4: Gas composition versus area (mol%)

	Plastic Waste				
	Plastic Bag	**Shampoo Bottle**	**Plastic Wrapper**	**Polystyrene**	**Mixture**
CH_4 (mol%)	4.18	2.52	3.50	0.49	Nil

4.6 Liquid product analysis

4.6.1 Liquid composition

The detailed GC-MS result is in appendix E and the summarized result is tabulated in table 4.4.

Table 4.5: GCMS analysis summarize result

Hydrocarbon group		Area %				
		Plastic Waste				
		Plastic Bag	**Shampoo Bottle**	**Plastic Wrapper**	**Polystyrene**	**Mixture**
Aliphatic	C_5-C_6	-	5.75	2.34	0.34	1.25
	C_7-C_9	7.81	4.52	9.02	-	18.18
	C_{10}-C_{12}	22.88	11.26	19.82	-	13.91
	C_{13}-C_{15}	27.02	24.04	23.34	-	12.57
	C_{16}-C_{18}	17.87	19.04	18.77	-	14.91
	C_{19}-C_{21}	14.96	27.22	17.16	-	15.73
	C_{22}-C_{24}	1.18	3.77	-	-	1.03
	C_{25}-C_{27}	-	-	-	-	-
	C_{28}-C_{30}	-	-	-	-	-
	> C_{30}	-	-	-	3.22	-
Aromatic	benzene	-	-	-	-	0.52
	toluene	-	-	-	4.9	0.97
	ethyl-benzene	0.51	-	-	10.4	5.45
	styrene	-	-	1.31	29.88	4.01
	xylenes	-	-	-	-	-
	isopropyl benzene	-	-	-	28.01	3.23
	alpha-methyl styrene	-	-	-	5.5	0.99
	> C_{10}	-	-	-	12.63	1.38

From table 4.4, the result shows that plastic bag fuel is rich in C_{13} – C_{15} same goes with the plastic wrapper. For shampoo bottle, C_{19} – C_{21} play a larger number in the liquid properties. For the polystyrene plastic fuel, styrene and isopropyl benzene seems to be the major component in the fuel since polystyrene is made from styrene.

According to Pinto et al., (1999), their research resulted in high aromatic composition in polystyrene and more alkanes rather than alkenes in polyethylene composition which supported our finding. For mixture of plastic wastes, it shows a mixture of both aliphatic and aromatic compound exist in the fuel.

4.6.2 Calorific value

The result for the calorific value test for each of the plastic sample is tabulated in table 4.5.

Table 4.6: Calorific value summarization for various plastic waste

	Plastic Waste					
	Plastic Bag	**Shampoo Bottle**	**Plastic Wrapper**	**Polystyrene**	**Mixture**	**RON 95**
RON	4209.31	3239.28	3003.53	2885.36	3355.02	3103.59

From table 4.5, the result shows that plastic bag calorific value is the highest among all others plastic which is 4209.31 $cal.g^{-1}$. Polystyrene produced the lowest calorific value (2885.36 $cal.g^{-1}$). When comparing the calorific value with a commercial product which is RON 95, the closest calorific value is plastic wrapper and shampoo bottle which is 3239.28 $cal.g^{-1}$and 3003.53 $cal.g^{-1}$.

4.6.3 Octane number

The result from the octane analysis were tabulated in table 4.6

Table 4.7: RON result

	Plastic Waste					
	Plastic Bag	**Shampoo Bottle**	**Plastic Wrapper**	**Polystyrene**	**Mixture**	**RON 95**
RON	89	100	84.1	98.7	93.2	95.2

From table 4.6 the result shows that shampoo bottle has the highest RON number which is 100. The second highest RON number is polystyrene which is 98.7. Both of these RON numbers shows a higher RON number compare to the commercial product RON 95.

4.6.4 Density, viscosity, moisture, and clarity

The result for all the testing is summarized in table 4.8.

Table 4.8: Summary of liquid fuel properties

	Plastic Waste					
	Plastic Bag	**Shampoo Bottle**	**Plastic Wrapper**	**Polystyrene**	**Mixture**	**RON 95**
Density ($g.ml^{-1}$)	0.76	0.78	0.78	0.91	0.79	0.72
Clarity (NTU)	2.68	3.46	3.21	5.67	8.67	2.48
Moisture%	2.97	2.35	2.88	2.45	2.64	4.15
Viscosity (cP)	2.244	0.6725	0.828	0.9355	1.281	0.6

Beside polystyrene and plastic mixture fuel, fuel from other plastic, namely plastic bag, shampoo bottle and plastic wrapper, have a density in a range of 0.76 – 0.78 $g.ml^{-1}$. The fuel is rich in aliphatic hydrocarbon (Table 4.4). The fuel consists of long chain hydrocarbon without any benzene ring that make the hydrocarbon less dense.

For polystyrene plastic waste fuel, the density is the highest among all of the plastic waste fuel. This result is related from subchapter 4.5 result. In the polystyrene fuel composition, there were approximately 12% of hydrocarbon $>C_{10,}$ also known as polycyclic aromatic. Polycyclic aromatic hydrocarbons are composed of two or more aromatic rings which are fused together when a pair of carbon atoms is shared between them. The density of the polycyclic aromatic is heavier compare to normal aromatic compound. According to Pinto et al., (1999), the density of plastic fuel varies with the

increase of temperature. They reported that the polystyrene fuel has boiling point in a range of <100 ˚C to <270 ˚C with a density of 0.7 – 0.85 $kg^3.m^{-3}$.

The highest viscosity value among all the plastics waste fuel is the plastic bag fuel which is 2.244 cP. For shampoo bottle, the viscosity of the fuel is quite low which his 0.6725 cP. It is believed that double bonds can reduce the kinematic viscosity of the liquid fuel. Another factor contributes in reducing the kinematic viscosity is the position of the double bond in the hydrocarbon. However, the position of the double bond is not a major factor that effect the kinematic viscosity. An additional double bond also plays a role where it helps decrease the kinematic viscosity of the fuel but it does not decrease the viscosity to the extent the introduction of the first double does (Kaufmann and Funke, 1938). The viscosity result for polystyrene also give a low value of the viscosity because due to their lack of oxygen or other heteroatoms (Knothe and Steidley, 2005).

The moisture content in the liquid fuel is in the range of 2.35 – 2.97% which is a quite low in percentage. Moisture in liquid fuel lowers the heating value and flame temperature, but on the other hand, water reduces the viscosity and enhances the fluidity, which is good for the atomization and combustion of bio-oil in the engine (Zhang et al., 2007).

Figure 4.6 clearly illustrates the clarity of the fuel that derived from various plastic type. It can be seen that the plastic bag waste fuel gives the lowest NTU number which mean the fuel is clear and translucent to be seen. This is because most of the composition in liquid fuel is between C_{10} – C_{15} for the plastic bag same goes with plastic wrapper.

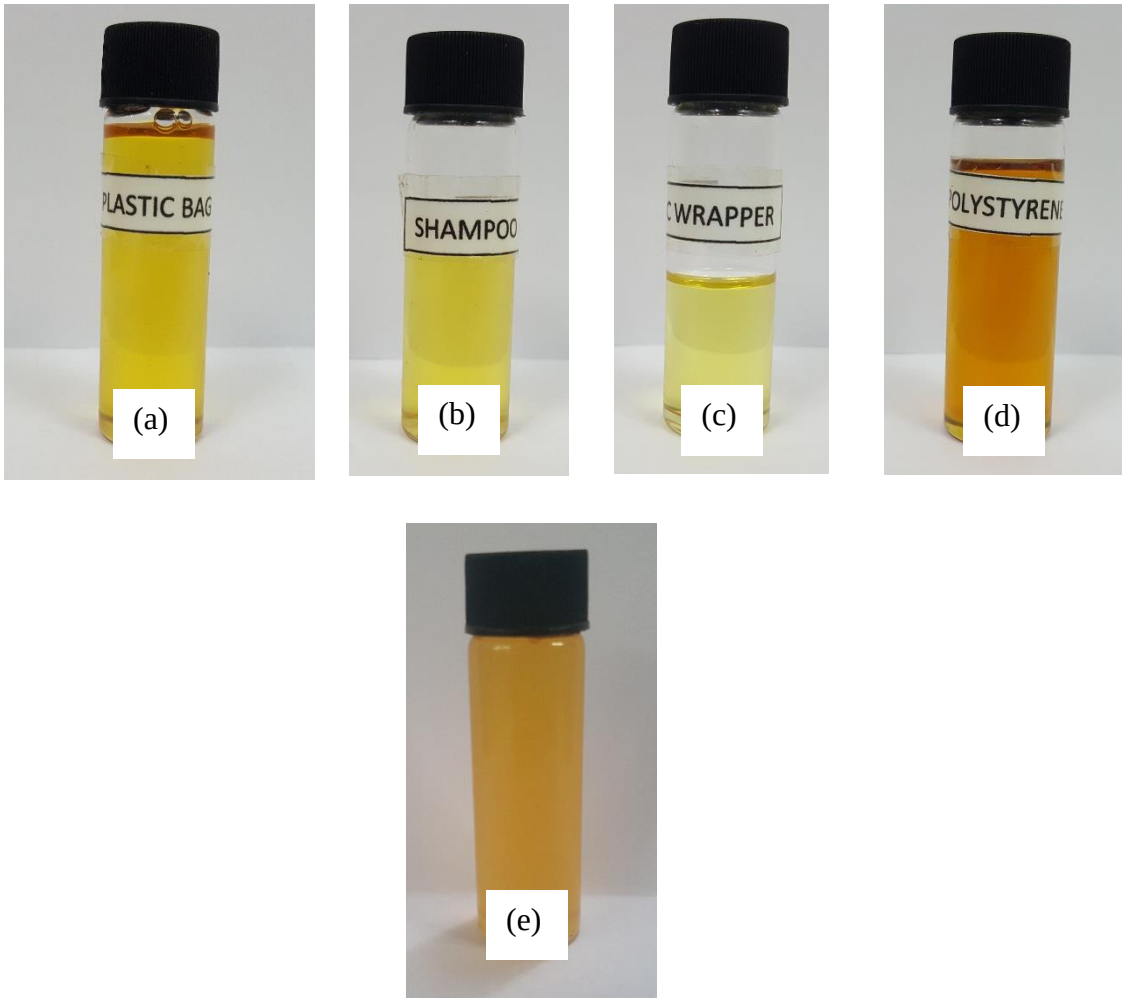

Figure 4.5: Plastic fuel (a) Plastic bag, (b) Shampoo bottle. (c) Plastic wrapper, (d) Polystyrene, (e) mixture of plastic waste

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The catalyst that derived from oil palm biomass ash is a mesoporous structure with pore size of 31.69 nm. It is also rich in Silica (23.5 %) and other minerals like Mg, Si, Al, Fe, K and Ca.

Pyrolysis of real plastic waste produced gas, wax, condensed liquid hydrocarbons and solid. The best liquid product can be obtained from Polystyrene > Shampoo Bottle > Plastic Bag > Plastic Wrapper. Meanwhile, the mixture of plastic waste yields about 48% of liquid fuel. The best composition and characteristic of the liquid fuel is from shampoo bottle because it is rich in $C_{19} – C_{21}$ (27 %) with 3239.28 $cal.g^{-1}$ calorific value and a low value of viscosity of 0.672 cP and a low value of moisture content which is 2.35%. The RON number of shampoo bottle fuel is 100 which is higher than the commercial product of RON 95. It is concluded that the liquid fuel derived from shampoo bottle is better and greener than a commercial product of RON 95 in term of calorific value, moisture, viscosity and RON number. The production cost is also low because the catalyst use is derived from waste itself.

5.2 Recommendation

For the recommendation for future work, there are actually other parameter can contribute to the quality of liquid fuel via pyrolysis of plastic waste such as retention time, pressure and type of reactor. For retention time, different plastic requires different retention time because some plastic has single, double or triple bond in the hydrocarbon chain that something need more time to crack the hydrocarbon chain into smaller one.

For the reactor, it is suggested that the reactor is custom made so the upper lid can be open so that it can easily be clean for the next batch of experiment. The example of the reactor is shown in figure 5.1

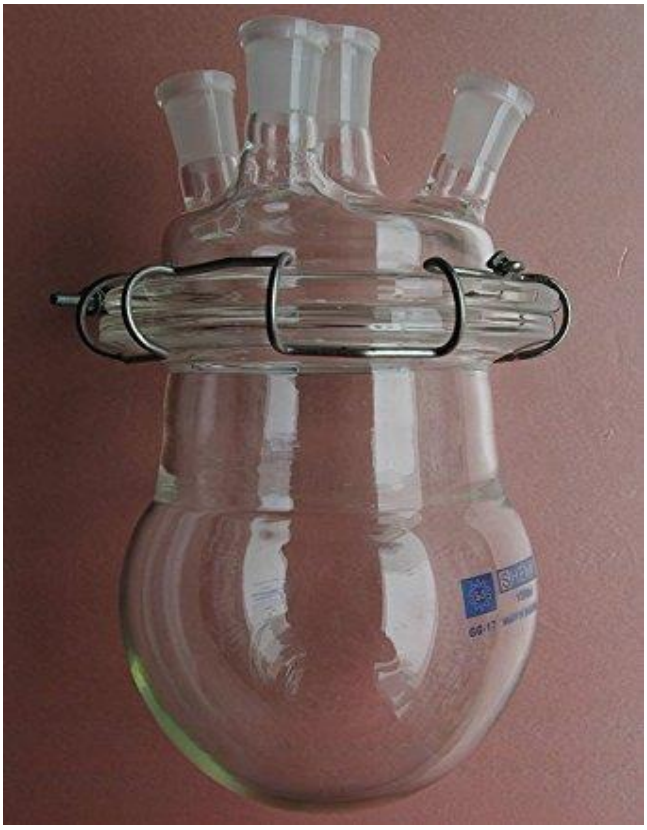

Figure 5.1: Custom made 1 liter round bottom flask

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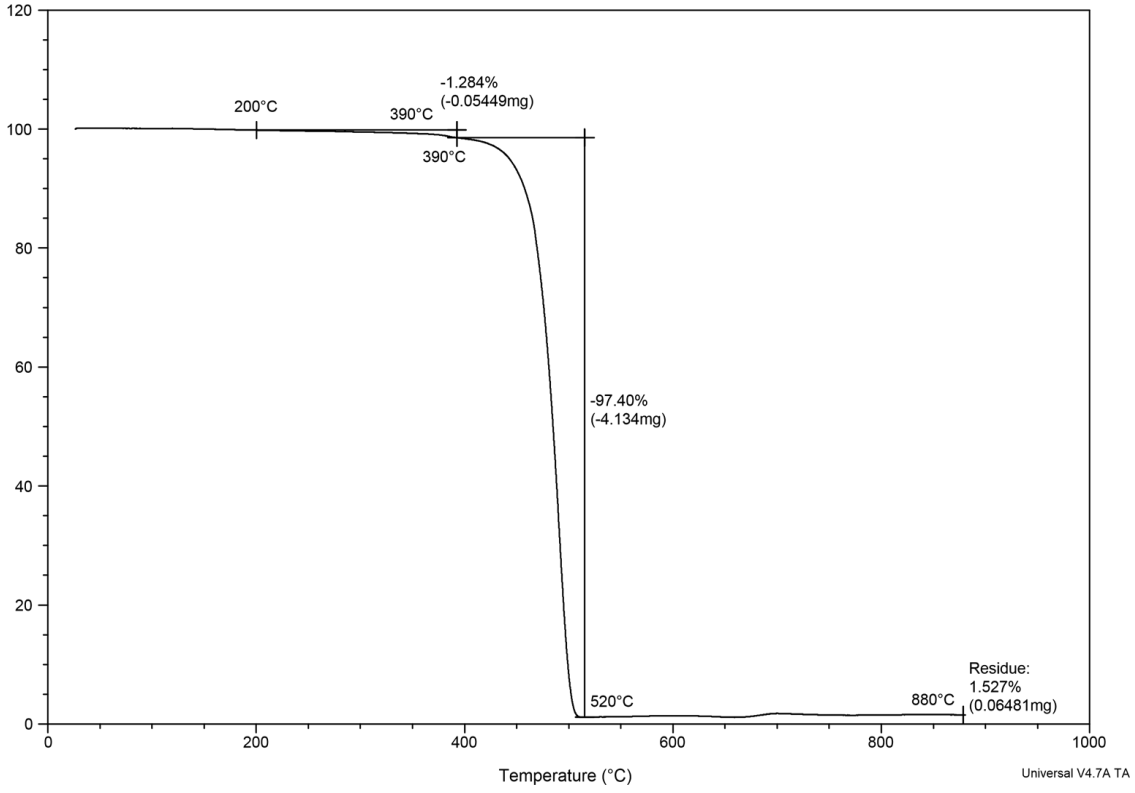
APPENDIX A – TGA ANALYSIS

Sample: HDPE

Size: 4.2450 mg

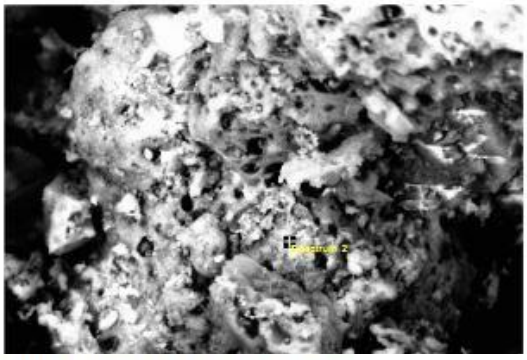
Method: Ramp



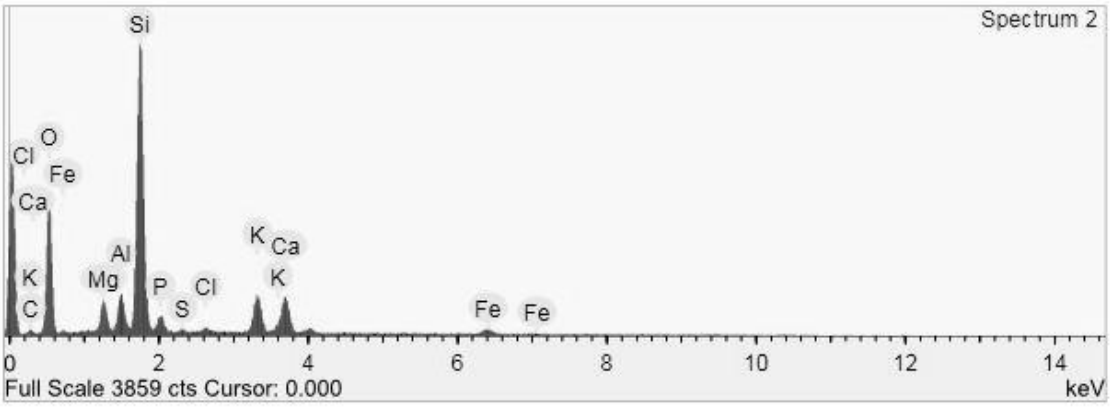
APPENDIX B – SEM WITH EDX ANALYSIS

Spectrum details
Project: New project Spectrum name: Spectrum 2

Electron Image
Image Width: 58.6 µm



Quantification Settings
Quantification method : All elements (normalised) Coating element : None



APPENDIX C – BET ANALYSIS

Full Report Set

ASAP 2020 V3.04 H Unit 1 Serial #: 1255 Page 1

Sample: 4
Operator: HALIM
Submitter: UMP
File: C:\2020\DATA\001-711.SMP

Started: 11/9/2016 2:18:16PM
Analysis Adsorptive: N2
Completed: 11/9/2016 5:24:03PM
Analysis Bath Temp.: -195.793 °C
Report Time: 11/11/2016 8:23:27AM
Thermal Correction: No
Sample Mass: 0.3110 g
Warm Free Space: 27.2363 cm³ Measured
Cold Free Space: 84.1917 cm³
Equilibration Interval: 5 s
Low Pressure Dose: None
Automatic Degas: Yes

Summary Report

Surface Area

Single point surface area at P/Po = 0.300121346: 1.3232 m²/g

BET Surface Area: 1.3736 m²/g

Langmuir Surface Area: 2.1490 m²/g

t-Plot Micropore Area: 0.0467 m²/g

t-Plot External Surface Area: 1.3269 m²/g

BJH Adsorption cumulative surface area of pores between 17.000 Å and 3000.000 Å diameter: 0.695 m²/g

BJH Desorption cumulative surface area of pores between 17.000 Å and 3000.000 Å diameter: 0.7775 m²/g

Pore Volume

Single point adsorption total pore volume of pores less than 1279.335 Å diameter at P/Po = 0.984634127: 0.002254 cm³/g

Single point desorption total pore volume of pores less than 795.043 Å diameter at P/Po = 0.975033947: 0.002746 cm³/g

t-Plot micropore volume: 0.000059 cm³/g

BJH Adsorption cumulative volume of pores between 17.000 Å and 3000.000 Å diameter: 0.005506 cm³/g

BJH Desorption cumulative volume of pores
between 17.000 Å and 3000.000 Å diameter: 0.005619 cm^3/g

Pore Size

Adsorption average pore width (4V/A by BET): 65.6422 Å

Desorption average pore width (4V/A by BET): 79.9752 Å

BJH Adsorption average pore diameter (4V/A): 316.962 Å

BJH Desorption average pore diameter (4V/A): 289.076 Å

Isotherm Tabular Report

Relative Pressure (P/Po)	Absolute Pressure (mmHg)	Quantity Adsorbed (mmol/g)	Elapsed Time (h:min)	Saturation Pressure (mmHg)
1.#QNAN0000	1.#QNAN0	1.#QNAN	01:06	760.439331
0.011172672	8.496140	0.01026	01:16	1.#QNAN0
0.034528383	26.256741	0.01222	01:18	1.#QNAN0
0.068950458	52.432640	0.01448	01:19	1.#QNAN0
0.080130254	60.934196	0.01500	01:20	1.#QNAN0
0.100145332	76.154449	0.01560	01:22	1.#QNAN0
0.120095809	91.325577	0.01655	01:23	1.#QNAN0
0.140166149	106.587852	0.01695	01:24	1.#QNAN0
0.160141527	121.777916	0.01763	01:26	1.#QNAN0
0.180131203	136.978851	0.01803	01:27	1.#QNAN0
0.200069901	152.141022	0.01861	01:28	1.#QNAN0
0.250037142	190.138077	0.01934	01:30	1.#QNAN0
0.300121346	228.224075	0.01938	01:31	1.#QNAN0
0.350119407	266.244568	0.01928	01:32	1.#QNAN0
0.419357297	318.895782	0.01845	01:34	1.#QNAN0
0.469322471	356.891266	0.01768	01:36	1.#QNAN0
0.519263245	394.868195	0.01642	01:37	1.#QNAN0
0.569183271	432.829346	0.01545	01:39	1.#QNAN0
0.619145475	470.822571	0.01392	01:40	1.#QNAN0
0.669087854	508.800720	0.01262	01:41	1.#QNAN0
0.719038260	546.784973	0.01193	01:43	1.#QNAN0
0.758952096	577.137024	0.01139	01:45	1.#QNAN0
0.788958505	599.955078	0.01096	01:46	1.#QNAN0
0.818861777	622.694702	0.01091	01:47	1.#QNAN0
0.838850479	637.894897	0.01118	01:49	1.#QNAN0
0.840011404	638.777710	0.01156	01:50	1.#QNAN0
0.860068490	654.029907	0.01191	01:51	1.#QNAN0
0.893718199	679.618469	0.01341	01:53	1.#QNAN0
0.904980946	688.183105	0.01562	01:54	1.#QNAN0

Isotherm Linear Plot

4 - Adsorption

Relative Pressure (P/Po)	Quantity Adsorbed (mmol/g)
0.0111727	0.0102609
0.0345284	0.0122246
0.0689505	0.0144788

0.0801303	0.0149983
0.100145	0.015605
0.120096	0.0165542
0.140166	0.0169488
0.160142	0.0176348
0.180131	0.0180306
0.20007	0.0186137
0.250037	0.0193393
0.300121	0.0193762
0.350119	0.0192765
0.419357	0.0184461
0.469322	0.0176808
0.519263	0.0164204
0.569183	0.0154504
0.619145	0.0139247
0.669088	0.0126172
0.719038	0.0119327
0.758952	0.011391
0.788959	0.0109591
0.818862	0.0109131
0.83885	0.0111846
0.840011	0.0115551
0.860068	0.0119107
0.893718	0.0134147
0.904981	0.015618
0.914976	0.0193664
0.925223	0.0214216
0.951287	0.0286136
0.953132	0.0300617
0.959306	0.0326748
0.981548	0.0545608
0.98243	0.0597996
0.984634	0.065018
0.999117	0.167253

4 - Desorption

Relative Pressure (P/Po)	Quantity Adsorbed (mmol/g)
0.999117	0.167253
0.975034	0.0792147
0.956975	0.0491755
0.93519	0.0336485
0.914743	0.0268084
0.88661	0.0223328
0.856419	0.0193964
0.82137	0.0178298
0.801297	0.0170944
0.781199	0.016748
0.751231	0.0167407
0.721243	0.0167603
0.680713	0.0171732
0.63111	0.0178527
0.580996	0.0184597
0.53098	0.0191309
0.481123	0.0175922
0.430725	0.016312
0.380585	0.0160822
0.330623	0.0157421

0.28061	0.0152623
0.230592	0.0139363
0.180636	0.0124753
0.122836	0.00932328

Isotherm Log Plot

4 - Adsorption

Relative Pressure (P/Po)	Quantity Adsorbed (mmol/g)
0.0111727	0.0102609
0.0345284	0.0122246
0.0689505	0.0144788
0.0801303	0.0149983
0.100145	0.015605
0.120096	0.0165542
0.140166	0.0169488
0.160142	0.0176348
0.180131	0.0180306
0.20007	0.0186137
0.250037	0.0193393
0.300121	0.0193762
0.350119	0.0192765
0.419357	0.0184461
0.469322	0.0176808
0.519263	0.0164204
0.569183	0.0154504
0.619145	0.0139247
0.669088	0.0126172
0.719038	0.0119327
0.758952	0.011391
0.788959	0.0109591
0.818862	0.0109131
0.83885	0.0111846
0.840011	0.0115551
0.860068	0.0119107
0.893718	0.0134147
0.904981	0.015618
0.914976	0.0193664
0.925223	0.0214216
0.951287	0.0286136
0.953132	0.0300617
0.959306	0.0326748
0.981548	0.0545608
0.98243	0.0597996
0.984634	0.065018
0.999117	0.167253

4 - Desorption

Relative Pressure (P/Po)	Quantity Adsorbed (mmol/g)
0.999117	0.167253
0.975034	0.0792147
0.956975	0.0491755
0.93519	0.0336485
0.914743	0.0268084
0.88661	0.0223328

0.856419	0.0193964
0.82137	0.0178298
0.801297	0.0170944
0.781199	0.016748
0.751231	0.0167407
0.721243	0.0167603
0.680713	0.0171732
0.63111	0.0178527
0.580996	0.0184597
0.53098	0.0191309
0.481123	0.0175922
0.430725	0.016312
0.380585	0.0160822
0.330623	0.0157421
0.28061	0.0152623
0.230592	0.0139363
0.180636	0.0124753
0.122836	0.00932328

BET Surface Area Report

BET Surface Area:	1.3736 ± 0.0450 m²/g
Slope:	71.263358 ± 2.293554 g/mmol
Y-Intercept:	-0.229769 ± 0.401199 g/mmol
C:	-309.152797
Qm:	0.01408 mmol/g
Correlation Coefficient:	0.9958823
Molecular Cross-Sectional Area:	0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (mmol/g)	1/[Q(Po/P - 1)]
0.068950458	0.01448	5.11483
0.080130254	0.01500	5.80804
0.100145332	0.01560	7.13174
0.120095809	0.01655	8.24490
0.140166149	0.01695	9.61813
0.160141527	0.01763	10.81251
0.180131203	0.01803	12.18526
0.200069901	0.01861	13.43683
0.250037142	0.01934	17.23949
0.300121346	0.01938	22.13120

BET Surface Area Plot

4

Relative Pressure (P/Po)	1/[Q(Po/P - 1)]
0.0689505	5.11483
0.0801303	5.80804
0.100145	7.13174
0.120096	8.2449

0.140166	9.61813
0.160142	10.8125
0.180131	12.1853
0.20007	13.4368
0.250037	17.2395
0.300121	22.1312

Langmuir Surface Area Report

Langmuir Surface Area:	2.1490 ± 0.0252 m²/g
Slope:	45.403853 ± 0.532055 g/mmol
Y-Intercept:	1341.362402 ± 70.773593 mmHg·g/mmol
b:	0.033849 1/mmHg
Qm:	0.02202 mmol/g
Correlation Coefficient:	0.999451
Molecular Cross-Sectional Area:	0.1620 nm²

Pressure (mmHg)	Quantity Adsorbed (mmol/g)	P/Q (mmHg·g/mmol)
52.432640	0.01448	3621.33
60.934196	0.01500	4062.75
76.154449	0.01560	4880.14
91.325577	0.01655	5516.78
106.587852	0.01695	6288.83
121.777916	0.01763	6905.53
136.978851	0.01803	7597.03
152.141022	0.01861	8173.60
190.138077	0.01934	9831.70
228.224075	0.01938	11778.56

t-Plot Report

Micropore Volume:	0.000059 cm³/g
Micropore Area:	0.0467 m²/g
External Surface Area:	1.3269 m²/g
Slope:	0.003827 ± 0.000218 mmol/g·Å
Y-Intercept:	0.001714 ± 0.000886 mmol/g
Correlation Coefficient:	0.990407
Surface Area Correction Factor:	1.000
Density Conversion Factor:	0.0015468
Total Surface Area (BET):	1.3736 m²/g
Thickness Range:	3.5000 Å to 5.0000 Å
Thickness Equation:	Harkins and Jura

t = [13.99 / (0.034 - log(P/Po))] ^ 0.5

Relative Pressure (P/Po)	Statistical Thickness (Å)	Quantity Adsorbed (mmol/g)

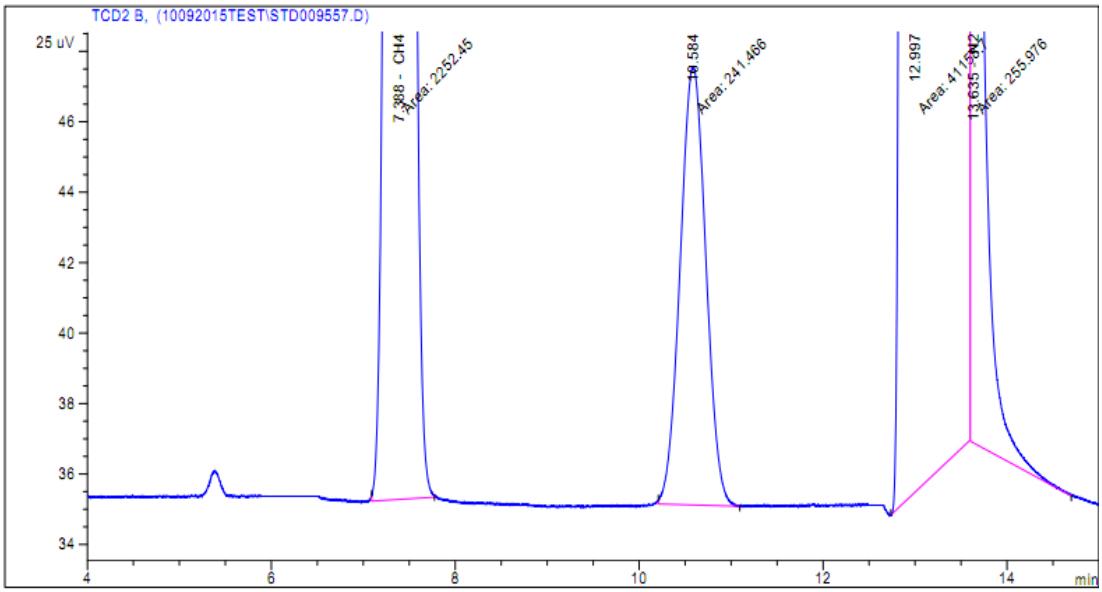
0.011172672	2.6542	0.01026
0.034528383	3.0582	0.01222
0.068950458	3.4209	0.01448
0.080130254	3.5183	0.01500
0.100145332	3.6794	0.01560
0.120095809	3.8285	0.01655
0.140166149	3.9706	0.01695
0.160141527	4.1068	0.01763
0.180131203	4.2394	0.01803
0.200069901	4.3693	0.01861
0.250037142	4.6901	0.01934
0.300121346	5.0130	0.01938
0.350119407	5.3445	0.01928
0.419357297	5.8313	0.01845
0.469322471	6.2121	0.01768
0.519263245	6.6264	0.01642
0.569183271	7.0844	0.01545
0.619145475	7.6000	0.01392

APPENDIX D – GAS ANALYSIS VIA GC-TCD

Plastic Wrapper

```
Data File C:\CHEM32\1\DATA\10092015TEST\STD009557.D
 Sample Name: DR RUZINAH

    ======================================================================
    Acq. Operator    : SUNNY
    Acq. Instrument : Instrument 1                    Location : Vial 2
    Injection Date  : 2/18/2016 12:52:35 PM              Inj :   1
                                                    Inj Volume : Manually
    Method          : C:\CHEM32\1\METHODS\GC_120_OK.M
    Last changed    : 4/5/2015 6:06:16 PM by agilent
    Sample Info     : PLASTIC KUIH+CALCINED ASH_1:10
```




```
  ======================================================================
                        External Standard Report
  ======================================================================

  Sorted By             :      Signal
  Calib. Data Modified  :      Thursday, September 26, 2013 4:56:27 PM
  Multiplier            :      1.0000
  Dilution              :      1.0000
  Use Multiplier & Dilution Factor with ISTDs

  Signal 1: TCD2 B,

  RetTime  Type     Area      Amt/Area    Amount   Grp   Name
   [min]          [25 uV*s]                [%]
  -------|------|----------|----------|----------|--|------------------
    5.483            -          -          -         H2
    7.388 MM     2252.45483 7.85386e-4    1.76905    CH4
   10.235            -          -          -         CO2
   13.635 MM      255.97603 2.08779e-4 5.34424e-2    N2
   14.193            -          -          -         CO

  Totals :                                1.82249


  1 Warnings or Errors :

  Warning : Calibrated compound(s) not found

  ======================================================================
```

Plastic Bag

```
Data File C:\CHEM32\1\DATA\10092015TEST\STD009415.D
 Sample Name: Real Plastic (Colorless) + Calcined Ash

    ======================================================================
    Acq. Operator    : SUNNY
    Acq. Instrument : Instrument 1                    Location : Vial 2
    Injection Date  : 2/12/2016 9:24:36 AM               Inj :   1
                                                    Inj Volume : Manually
    Acq. Method     : C:\CHEM32\1\METHODS\GC_120_OK.M
    Last changed    : 2/11/2016 3:38:58 PM by SUNNY
                      (modified after loading)
    Analysis Method : C:\CHEM32\1\METHODS\GC_120_OK.M
```

```
------------------------------------------------------------------------
                        External Standard Report
------------------------------------------------------------------------

Sorted By             :      Signal
Calib. Data Modified  :      Thursday, September 26, 2013 4:56:27 PM
Multiplier            :      1.0000
Dilution              :      1.0000
Use Multiplier & Dilution Factor with ISTDs

Signal 1: TCD2 B,

RetTime  Type     Area      Amt/Area    Amount   Grp   Name
 [min]          [25 uV*s]                 [%]
-------|------|----------|----------|----------|--|------------------
  5.483            -          -          -          H2
  7.427 MM       27.39453 7.85386e-4 2.15153e-2     CH4
 10.235            -          -          -          CO2
 13.660 MM     1280.68579 2.08779e-4 2.67380e-1     N2
 14.193            -          -          -          CO

Totals :                               2.88895e-1
```

Shampoo Bottle

```
Data File C:\CHEM32\1\DATA\10092015TEST\STD009433.D
Sample Name: SHAMPOPLASTIC:10CALASH

------------------------------------------------------------------------
Acq. Operator   : SUNNY
Acq. Instrument : Instrument 1                    Location : Vial 2
Injection Date  : 2/13/2016 11:00:16 AM                Inj :   1
                                                 Inj Volume : Manually
Acq. Method     : C:\CHEM32\1\METHODS\GC_120_OK.M
Last changed    : 2/11/2016 3:38:58 PM by SUNNY
                  (modified after loading)
Analysis Method : C:\CHEM32\1\METHODS\GC 120 OK.M
```

```
---------------------------------------------------------------------
                    External Standard Report
---------------------------------------------------------------------

Sorted By             :      Signal
Calib. Data Modified  :      Thursday, September 26, 2013 4:56:27 PM
Multiplier            :      1.0000
Dilution              :      1.0000
Use Multiplier & Dilution Factor with ISTDs

Signal 1: TCD2 B,

RetTime  Type      Area      Amt/Area     Amount    Grp   Name
 [min]          [25 uV*s]                  [%]
-------|------|----------|----------|----------|--|------------------
  5.483             -          -          -          H2
  7.408 MM     1620.43433 7.85386e-4    1.27267     CH4
 10.235            -          -          -          CO2
 13.666 MM     1410.16699 2.08779e-4 2.94413e-1     N2
 14.193            -          -          -          CO

Totals :                                 1.56708
```

Polystyrene

```
ata File C:\CHEM32\1\DATA\10092015TEST\STD009558.D
Sample Name: DR RUZINAH

   ---------------------------------------------------------------------
   Acq. Operator   : SUNNY
   Acq. Instrument : Instrument 1                    Location : Vial 2
   Injection Date  : 2/18/2016 1:34:43 PM                 Inj :   1
                                                  Inj Volume : Manually
   Method          : C:\CHEM32\1\METHODS\GC_120_OK.M
   Last changed    : 4/5/2015 6:06:16 PM by agilent
```

External Standard Report

Sorted By : Signal
Calib. Data Modified : Thursday, September 26, 2013 4:56:27 PM
Multiplier : 1.0000
Dilution : 1.0000
Use Multiplier & Dilution Factor with ISTDs

Signal 1: TCD2 B,

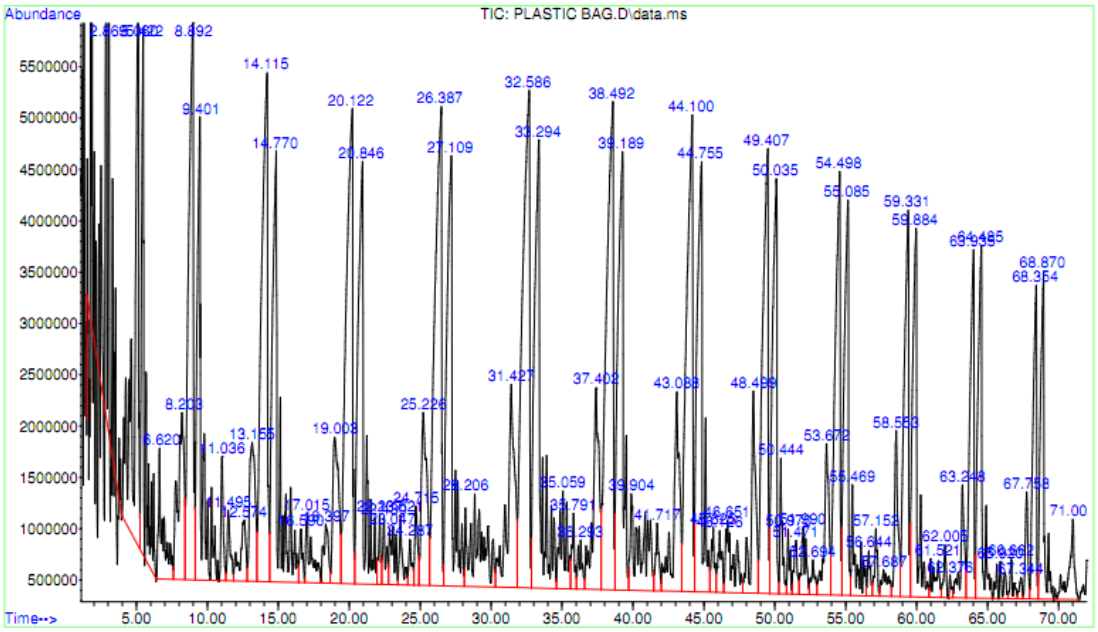
RetTime [min]	Type	Area [25 uV*s]	Amt/Area	Amount [%]	Grp	Name
5.483		-	-	-		H2
7.402	MM	316.99313	7.85386e-4	2.48962e-1		CH4
10.235		-	-	-		CO2
13.358		-	-	-		N2
14.193		-	-	-		CO

Totals : 2.48962e-1

APPENDIX E – GC-MS ANALYSIS

Plastic Bag

```
File       :D:\Data\dr ruzinah\ALI KA13142\230216\PLASTIC BAG.D
Operator   : ALI
Acquired   : 23 Feb 2016  16:07     using AcqMethod LIQUID FUEL.M
Instrument :    GCMSD
Sample Name: PLASTIC BAG
Misc Info  :
Vial Number: 2
```



?k#	RT	Area%	Library/ID	Ref#	CAS#	Qual
1	2.871	2.34	C:\Database\NIST05a.L			
			cis-1-Butyl-2-methylcyclopropane	6621	038851-69-3	95
			1-Octene	6442	000111-66-0	90
			1-Octene	6440	000111-66-0	81
2	5.061	2.89	C:\Database\NIST05a.L			
			Cyclopropane, 1-methyl-2-pentyl-	11252	041977-37-1	95
			1-Nonene	11145	000124-11-8	93
			1-Nonene	11144	000124-11-8	93
3	5.424	1.90	C:\Database\NIST05a.L			
			Nonane	12267	000111-84-2	94
			Nonane	12268	000111-84-2	94
			Nonane	12269	000111-84-2	90
4	6.620	0.68	C:\Database\NIST05a.L			
			Cyclopentene, 1-butyl-	10315	002423-01-0	68
			Cyclohexene, 3,3,5-trimethyl-	10361	000503-45-7	59
			Cyclopentene,1-(2-methylpropyl)-	10377	053098-47-8	53
5	8.201	1.24	C:\Database\NIST05a.L			
			1,11-Dodecadiene	33507	005876-87-9	58
			1,11-Dodecadiene	33506	005876-87-9	58
			1,13-Tetradecadiene	52919	021964-49-8	47
6	8.895	3.31	C:\Database\NIST05a.L			
			1-Decene	17320	000872-05-9	97
			1-Decene	17321	000872-05-9	97
			Cyclooctane, 1,2-dimethyl-	17395	013151-94-5	94
7	9.397	2.53	C:\Database\NIST05a.L			
			Decane	18485	000124-18-5	95
			Decane	18487	000124-18-5	95
			Decane	18486	000124-18-5	94
8	11.032	0.34	C:\Database\NIST05a.L			
			Cyclohexene, 1-butyl-	16309	003282-53-9	43
			Naphthalene, decahydro-	16321	000091-17-8	43
			Benzylamine	5017	000100-46-9	38
9	11.491	0.26	C:\Database\NIST05a.L			
			Cyclohexene, 1-butyl-	16309	003282-53-9	94
			Cyclohexane, 1-methyl-4-(1-methyle thenyl)-, cis-	16436	001879-07-8	52
			Spiro[2.5]octane-1,1-dicarbonitril e, 4-methyl-	38963	1000151-43-1	47
10	12.570	0.42	C:\Database\NIST05a.L			
			cis-Decalin, 2-syn-methyl-	24400	1000155-85-6	76
			3,4-Octadiene, 7-methyl-	10330	037050-05-8	68
			Naphthalene, decahydro-2-methyl-	24414	002958-76-1	68
11	13.157	0.95	C:\Database\NIST05a.L			
			cis-9-Tetradecen-1-ol	65989	035153-15-2	52
			5-Undecyne	24365	002294-72-6	49
			Cyclodecene	16280	003618-12-0	46
12	14.119	3.67	C:\Database\NIST05a.L			
			1-Undecene	25902	000821-95-4	95

Pk#	RT	Area%	Library/ID	Ref#	CAS#	Qual
			1-Undecene	25904	000821-95-4	93
			3-Undecene, (Z)-	25915	000821-97-6	93
13	14.770	3.10	C:\Database\NIST05a.L			
			Undecane	27239	001120-21-4	95
			Undecane	27238	001120-21-4	94
			Undecane	27237	001120-21-4	87
14	16.586	0.19	C:\Database\NIST05a.L			
			3,4-Octadiene, 7-methyl-	10330	037050-05-8	60
			3,4-Octadiene, 7-methyl-	10322	037050-05-8	60
			Cyclohexene, 1,2-dimethyl-	5818	001674-10-8	49
15	17.014	0.43	C:\Database\NIST05a.L			
			2-Decalone,c&t	24036	004832-17-1	58
			trans-Decalin, 2-methyl-	24396	1000152-47-3	55
			Cyclohexene, 1-pentyl-	24388	015232-85-6	53
16	18.402	0.35	C:\Database\NIST05a.L			
			Bicyclo[3.1.1]heptane, 2,6,6-trimethyl-	16398	000473-55-2	58
			5-Undecyne	24356	002294-72-6	55
			6-Methyloctahydrocoumarin	34575	080648-29-9	55
17	19.000	1.05	C:\Database\NIST05a.L			
			1,11-Dodecadiene	33507	005876-87-9	96
			Cyclododecene	33497	001501-82-2	93
			1,11-Dodecadiene	33506	005876-87-9	90
18	20.122	3.74	C:\Database\NIST05a.L			
			1-Dodecene	34945	000112-41-4	96
			1-Dodecene	34944	000112-41-4	96
			Cyclododecane	34948	000294-62-2	90
19	20.848	3.02	C:\Database\NIST05a.L			
			Dodecane	36431	000112-40-3	96
			Dodecane	36430	000112-40-3	94
			Dodecane	36429	000112-40-3	93
20	22.141	0.18	C:\Database\NIST05a.L			
			Cyclohexane, hexyl-	34975	004292-75-5	68
			Cyclohexane, (4-methylpentyl)-	35057	061142-20-9	64
			Cyclohexane, hexyl-	34974	004292-75-5	62
21	22.429	0.25	C:\Database\NIST05a.L			
			Cyclopropane, 1-butyl-2-pentyl-, trans-	35084	074663-87-9	53
			6-Dodecene, (E)-	34971	007206-17-9	50
			6-Dodecene, (E)-	34957	007206-17-9	45
22	23.049	0.35	C:\Database\NIST05a.L			
			6-Tridecene, (Z)-	44628	006508-77-6	76
			6-Tridecene, (E)-	44627	006434-76-0	72
			5-Tridecene, (E)-	44624	023051-84-5	72
23	23.626	0.26	C:\Database\NIST05a.L			
			9-Methylbicyclo[3.3.1]nonane	16338	025107-01-1	53
			Cycloheptane, methyl-	6507	004126-78-7	38
			Cyclopentane, 1,2-dimethyl-3-(1-me	17461	000489-20-3	30

			thylethyl)-			
24	24.288	0.16	C:\Database\NIST05a.L			
			Bicyclo[2.2.1]heptane, 2,2,3-trime thyl-, endo-	16427	020536-40-7	83
			Bicyclo[2.2.1]heptane, 2,2,3-trime thyl-, exo-	16425	020536-41-8	46
			1-Methyl-2-methylenecyclohexane	5854	002808-75-5	44
25	24.715	0.27	C:\Database\NIST05a.L			
			5-Eicosyne	110845	074685-31-7	64
			Cyclodecanol	27045	001502-05-2	58
			1-Hexadecyne	73057	000629-74-3	49
26	25.228	1.17	C:\Database\NIST05a.L			
			1-Heptadecyne	82655	026186-00-5	90
			cis-9-Tetradecen-1-ol	65991	035153-15-2	90
			cis-9-Tetradecen-1-ol	65989	035153-15-2	86
27	26.392	3.88	C:\Database\NIST05a.L			
			1-Tridecene	44618	002437-56-1	99
			1-Tridecene	44614	002437-56-1	98
			1-Tridecene	44617	002437-56-1	97
28	27.108	3.09	C:\Database\NIST05a.L			
			Tridecane	46086	000629-50-5	95
			Tridecane	46084	000629-50-5	95
			Tridecane	46085	000629-50-5	95
29	28.208	1.22	C:\Database\NIST05a.L			
			Bicyclo[3.1.1]heptane, 2,6,6-trime thyl-, [1R-(1.alpha.,2.beta.,5.alp ha.)]-	16447	004795-86-2	64
			Bicyclo[3.1.1]heptane, 2,6,6-trime thyl-	16398	000473-55-2	49
			Cyclododecene	33497	001501-82-2	49
30	31.424	1.70	C:\Database\NIST05a.L			
			1,13-Tetradecadiene	52919	021964-49-8	91
			5-Nonadecen-1-ol	113464	1000131-11-9	91
			1,13-Tetradecadiene	52921	021964-49-8	83
31	32.588	4.27	C:\Database\NIST05a.L			
			2-Tetradecene, (E)-	54521	035953-53-8	98
			1-Tetradecene	54512	001120-36-1	96
			1-Dodecene	34946	000112-41-4	94
32	33.293	3.43	C:\Database\NIST05a.L			
			Tetradecane	55975	000629-59-4	97
			Tetradecane	55973	000629-59-4	96
			Tetradecane	55972	000629-59-4	96
33	35.056	0.63	C:\Database\NIST05a.L			
			Cyclotetradecane	54517	000295-17-0	91
			Cyclododecane	34949	000294-62-2	91
			Pentafluoropropionic acid, octadec yl ester	174660	1000280-07-7	90
34	35.793	0.24	C:\Database\NIST05a.L			

Pk#	RT	Area%	Library/ID	Ref#	CAS#	Qual
			Cyclohexene, 1-octyl-	52924	015232-87-8	81
			Cyclohexene,1-hexyl-	33523	003964-66-7	72
			Cyclohexene,1-heptyl-	43182	015232-86-7	72
35	36.295	0.22	C:\Database\NIST05a.L			
			1-Dodecene	34944	000112-41-4	43
			Cyclooctane, 1,5-dimethyl-	17397	021328-57-4	38
			Cyclopropane, 1-butyl-2-pentyl-, cis-	35079	074663-88-0	38
36	37.406	1.48	C:\Database\NIST05a.L			
			1-Pentadecyne	63039	000765-13-9	87
			1,12-Tridecadiene	43179	021964-48-7	86
			1,12-Tridecadiene	43178	021964-48-7	86
37	38.495	4.05	C:\Database\NIST05a.L			
			1-Pentadecene	64454	013360-61-7	97
			1-Pentadecene	64457	013360-61-7	95
			1-Pentadecene	64455	013360-61-7	93
38	39.189	3.00	C:\Database\NIST05a.L			
			Pentadecane	66066	000629-62-9	97
			Pentadecane	66065	000629-62-9	93
			Heptadecane	85524	000629-78-7	91
39	39.905	1.18	C:\Database\NIST05a.L			
			Cyclopentadecane	64459	000295-48-7	52
			1,12-Tridecadiene	43178	021964-48-7	46
			1-Docosene	129889	001599-67-3	46
40	41.721	0.27	C:\Database\NIST05a.L			
			Cyclohexene, 1-nonyl-	63043	015232-88-9	70
			Bicyclo[3.1.0]hexan-2-one, 5-(1-methylethyl)-	17044	000513-20-2	62
			1H-Indene, octahydro-5-methyl-	16347	019744-64-0	58
41	43.088	1.41	C:\Database\NIST05a.L			
			1,15-Hexadecadiene	73063	021964-51-2	95
			1,13-Tetradecadiene	52921	021964-49-8	94
			7-Hexadecyn-1-ol	83989	000822-21-9	93
42	44.103	3.51	C:\Database\NIST05a.L			
			1-Hexadecene	74521	000629-73-2	99
			Z-8-Hexadecene	74523	1000130-87-5	98
			1-Hexadecene	74519	000629-73-2	96
43	44.755	2.88	C:\Database\NIST05a.L			
			Hexadecane	76091	000544-76-3	98
			Hexadecane	76093	000544-76-3	98
			Hexadecane	76092	000544-76-3	96
44	45.620	0.24	C:\Database\NIST05a.L			
			3-(But-3-enyl)-cyclohexanone	24098	003636-03-1	62
			Cyclohexane, 1-(cyclohexylmethyl)-3-methyl-, trans-	52955	054823-95-9	53
			Cyclohexane, 1-(cyclohexylmethyl)-2-methyl-, cis-	52954	054824-04-3	53
45	46.122	0.27	C:\Database\NIST05a.L			

?k#	RT	Area%	Library/ID	Ref#	CAS#	Qual
			Trichloroacetic acid, undec-2-enyl ester	132994	1000299-26-1	62
			Z-11,13-Dimethyl-11-tetradecen-1-ol acetate	113402	1000131-36-6	58
			Bicyclo[3.1.1]heptane, 2,6,6-trimethyl-, [1R-(1.alpha.,2.alpha.,5.alpha.)]-	16450	004863-59-6	55
46	46.656	0.64	C:\Database\NIST05a.L			
			3-Hexadecene, (Z)-	74526	034303-81-6	95
			Cyclopentadecane	64458	000295-48-7	95
			Cyclohexadecane	74524	000295-65-8	93
47	48.493	1.08	C:\Database\NIST05a.L			
			1,15-Hexadecadiene	73063	021964-51-2	90
			cis-11-Tetradecen-1-ol	65996	034010-15-6	89
			1,19-Eicosadiene	110851	014811-95-1	80
48	49.401	2.92	C:\Database\NIST05a.L			
			3-Heptadecene, (Z)-	84042	1000141-67-3	99
			E-14-Hexadecenal	83987	330207-53-9	99
			8-Heptadecene	84039	002579-04-6	95
49	50.032	2.21	C:\Database\NIST05a.L			
			Heptadecane	85523	000629-78-7	96
			Heptadecane	85525	000629-78-7	96
			Heptadecane	85524	000629-78-7	93
50	50.448	0.37	C:\Database\NIST05a.L			
			3-Heptadecene, (Z)-	84042	1000141-67-3	95
			1-Heptadecene	84041	006765-39-5	92
			E-14-Hexadecenal	83987	330207-53-9	86
51	50.972	0.18	C:\Database\NIST05a.L			
			Cyclohexadecane	74524	000295-65-8	96
			5-Octadecene, (E)-	93546	007206-21-5	92
			8-Heptadecene	84040	054290-12-9	83
52	51.474	0.22	C:\Database\NIST05a.L			
			Tridecanedial	65765	063521-76-6	70
			Bicyclo[3.1.1]heptane, 2,6,6-trimethyl-	16406	000473-55-2	49
			Oxirane, tridecyl-	76039	018633-25-5	46
53	51.986	0.35	C:\Database\NIST05a.L			
			Cyclohexane, 1,1'-(1,4-butanediyl)bis-	73075	006165-44-2	49
			Cyclohexane, (1-methylpropyl)-	17414	007058-01-7	49
			Cyclohexane, 1,1'-(1,5-pentanediyl)bis-	82660	054833-31-7	46
54	52.691	0.15	C:\Database\NIST05a.L			
			12-Heptadecyn-1-ol	93521	056554-76-8	55
			1H-Indene, octahydro-5-methyl-	16347	019744-64-0	46
			Spiro[5.6]dodecane	33517	000181-15-7	42
55	53.674	0.84	C:\Database\NIST05a.L			
			1-Hexadecyne	73057	000629-74-3	93
			1,19-Eicosadiene	110850	014811-95-1	91

Pk#	RT	Area%	Library/ID	Ref#	CAS#	Qual
			1,19-Eicosadiene	110851	014811-95-1	91
56	54.497	2.55	C:\Database\NIST05a.L			
			1-Octadecene	93544	000112-88-9	99
			E-15-Heptadecenal	93518	1000130-97-9	99
			1-Nonadecene	102860	018435-45-5	95
57	55.084	1.96	C:\Database\NIST05a.L			
			Octadecane	94931	000593-45-3	98
			Hexadecane	76093	000544-76-3	95
			Octadecane	94930	000593-45-3	94
58	55.469	0.52	C:\Database\NIST05a.L			
			5-Octadecene, (E)-	93546	007206-21-5	99
			E-7-Octadecene	93545	1000130-92-0	95
			E-15-Heptadecenal	93518	1000130-97-9	93
59	56.644	0.15	C:\Database\NIST05a.L			
			Oxirane, hexadecyl-	104255	007390-81-0	91
			(-)-trans-Pinane	16289	033626-25-4	60
			1,13-Tetradecadiene	52921	021964-49-8	58
60	57.156	0.22	C:\Database\NIST05a.L			
			1-Nonadecene	102859	018435-45-5	72
			11-Dodecenol	45961	035289-31-7	60
			Cyclododecanemethanol	55891	001892-12-2	49
61	57.691	0.20	C:\Database\NIST05a.L			
			Z-5-Nonadecene	102861	1000131-11-8	96
			1-Nonadecene	102860	018435-45-5	90
			Hexadecanenitrile	83236	000629-79-8	90
62	58.556	0.66	C:\Database\NIST05a.L			
			1,19-Eicosadiene	110851	014811-95-1	91
			18-Nonadecen-1-ol	113465	1000142-89-2	91
			1,13-Tetradecadiene	52921	021964-49-8	89
63	59.336	2.09	C:\Database\NIST05a.L			
			Z-5-Nonadecene	102861	1000131-11-8	99
			1-Nonadecene	102860	018435-45-5	95
			1-Nonadecene	102859	018435-45-5	94
64	59.880	2.06	C:\Database\NIST05a.L			
			Nonadecane	104271	000629-92-5	96
			Nonadecane	104272	000629-92-5	96
			Heptadecane	85523	000629-78-7	93
65	61.525	0.26	C:\Database\NIST05a.L			
			1,19-Eicosadiene	110851	014811-95-1	93
			Bicyclo[10.8.0]eicosane, cis-	110854	1000155-82-2	64
			Cyclododecanemethanol	55891	001892-12-2	62
66	62.006	0.16	C:\Database\NIST05a.L			
			Decane, 2-cyclohexyl-	74534	013151-73-0	53
			n-Amylcyclohexane	25925	029949-27-7	52
			Cyclohexane, (1-methylethyl)-	11239	000696-29-7	47
67	62.380	0.06	C:\Database\NIST05a.L			
			1-Eicosene	112101	003452-07-1	91

Pk#	RT	Area%	Library/ID	Ref#	CAS#	Qual
			E-14-Hexadecenal	83987	330207-53-9	83
			1-Hexadecanol, 2-methyl-	96338	002490-48-4	55
68	63.245	0.51	C:\Database\NIST05a.L			
			1,19-Eicosadiene	110850	014811-95-1	94
			1,19-Eicosadiene	110851	014811-95-1	90
			Bicyclo[10.8.0]eicosane, (E)-	110853	1000155-85-0	90
69	63.940	1.68	C:\Database\NIST05a.L			
			Cycloeicosane	112104	000296-56-0	98
			E-14-Hexadecenal	83987	330207-53-9	98
			1-Nonadecene	102860	018435-45-5	94
70	64.484	1.82	C:\Database\NIST05a.L			
			Eicosane	113492	000112-95-8	99
			Heptadecane	85523	000629-78-7	95
			Heptadecane	85525	000629-78-7	95
71	65.916	0.23	C:\Database\NIST05a.L			
			Cyclohexane, 1-(cyclohexylmethyl)-3-methyl-, trans-	52955	054823-95-9	59
			Oxalic acid, cyclohexylmethyl propyl ester	76956	1000309-68-1	50
			Cyclopentane, 1,2-dimethyl-3-(1-methylethyl)-	17461	000489-20-3	50
72	66.663	0.14	C:\Database\NIST05a.L			
			Decane, 2-cyclohexyl-	74534	013151-73-0	86
			Cyclohexane, (1-methylpropyl)-	17414	007058-01-7	64
			Cyclohexane, (1-methylpropyl)-	17413	007058-01-7	59
73	67.347	0.07	C:\Database\NIST05a.L			
			1,19-Eicosadiene	110851	014811-95-1	64
			E,E,Z-1,3,12-Nonadecatriene-5,14-diol	121084	1000131-11-4	59
			Cyclododecanemethanol	55891	001892-12-2	58
74	67.753	0.33	C:\Database\NIST05a.L			
			Octadecanal	104240	000638-66-4	94
			1,19-Eicosadiene	110851	014811-95-1	91
			1,19-Eicosadiene	110850	014811-95-1	91
75	68.351	1.33	C:\Database\NIST05a.L			
			Z-5-Nonadecene	102861	1000131-11-8	99
			1-Nonadecene	102860	018435-45-5	97
			10-Heneicosene (c,t)	121168	095008-11-0	95
76	68.875	1.53	C:\Database\NIST05a.L			
			Heneicosane	122435	000629-94-7	99
			Heneicosane	122436	000629-94-7	96
			Octadecane	94930	000593-45-3	95
77	71.000	0.51	C:\Database\NIST05a.L			
			Benzenemethanamine, N-hydroxy-N-(phenylmethyl)-	66600	000621-07-8	12
			Dibenzylamine, N-nitro-	86498	095835-70-4	12
			1-Pentene, 3,3,4-trimethyl-5-phenyl-	48772	1000150-35-3	10

Shampoo Bottle

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File       :D:\Data\dr ruzinah\ALI KA13142\230216\SHAMPOO BOTTLE.D
Operator   : ALI
Acquired   : 23 Feb 2016  17:26     using AcqMethod LIQUID FUEL.M
Instrument :    GCMSD
Sample Name: SHAMPOO BOTTLE
Misc Info  :
Vial Number: 3
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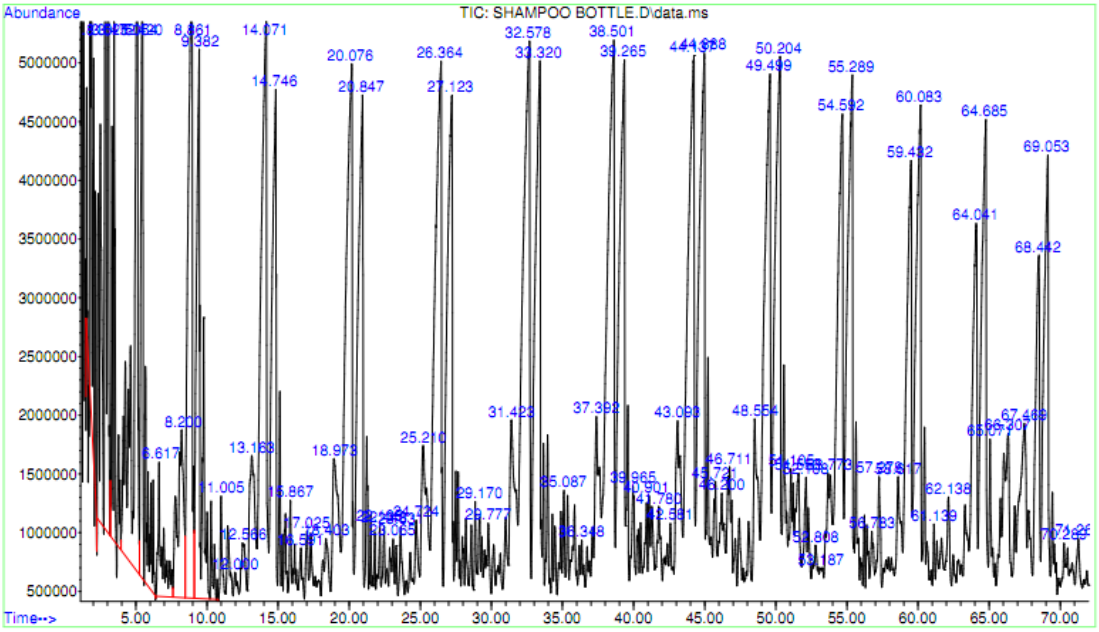

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1	1.813	0.94	C:\Database\NIST05a.L			
			Isopropylcyclobutane	3267	000872-56-0	87
			1-Heptene	3229	000592-76-7	86
			1-Heptene	3228	000592-76-7	76
2	3.020	1.60	C:\Database\NIST05a.L			
			Octane	7421	000111-65-9	91
			Heptane, 2,4-dimethyl-	12289	002213-23-2	72
			Heptane, 2,4-dimethyl-	12300	002213-23-2	72
3	3.469	0.62	C:\Database\NIST05a.L			
			Cyclotrisiloxane, hexamethyl-	73123	000541-05-9	87
			Cyclotrisiloxane, hexamethyl-	73121	000541-05-9	83
			Cyclotrisiloxane, hexamethyl-	73122	000541-05-9	64
4	5.050	1.44	C:\Database\NIST05a.L			
			Cyclopropane, 1-methyl-2-pentyl-	11252	041977-37-1	94
			1-Nonene	11145	000124-11-8	93
			1-Nonene	11144	000124-11-8	93
5	5.424	0.95	C:\Database\NIST05a.L			
			Nonane	12268	000111-84-2	94
			Nonane	12267	000111-84-2	94
			Nonane	12269	000111-84-2	90
6	6.620	0.27	C:\Database\NIST05a.L			
			Cyclopentene, 1-butyl-	10315	002423-01-0	68
			4-Octyne, 2-methyl-	10295	010306-94-2	59
			1H-Indene, octahydro-, trans-	10348	003296-50-2	52
7	8.201	0.52	C:\Database\NIST05a.L			
			1,11-Dodecadiene	33507	005876-87-9	52
			Methoxyacetic acid, 1-cyclopentyle thyl ester	47053	1000282-69-5	47
			Cyclohexanemethanol, 2-methyl-	12230	002105-40-0	43
8	8.863	1.42	C:\Database\NIST05a.L			
			1-Decene	17320	000872-05-9	97
			1-Decene	17321	000872-05-9	97
			Cyclooctane, 1,2-dimethyl-	17395	013151-94-5	94
9	9.387	1.26	C:\Database\NIST05a.L			
			Decane	18487	000124-18-5	95
			Decane	18485	000124-18-5	95
			Decane	18488	000124-18-5	94
10	11.000	0.22	C:\Database\NIST05a.L			
			Cyclopentene, 1-pentyl-	16319	004291-98-9	72
			Naphthalene, decahydro-	16321	000091-17-8	68
			Cyclopentene, 1-(3-methylbutyl)-	16366	037689-15-9	59
11	12.004	0.05	C:\Database\NIST05a.L			
			Bicyclo[3.1.1]heptane, 2,6,6-trime thyl-, [1R-(1.alpha.,2.alpha.,5.al pha.)]-	16450	004863-59-6	93
			Cyclooctene, 1,2-dimethyl-	16326	054299-96-6	43
			Bicyclo[2.2.2]octane, 2-methyl-	10368	000766-53-0	42
12	12.570	0.14	C:\Database\NIST05a.L			

Pk#	RT	Area%	Library/ID	Ref#	CAS#	Qual
			Naphthalene, decahydro-2-methyl-	24413	002958-76-1	72
			Cyclohexene, 1,2-dimethyl-	5818	001674-10-8	64
			Bicyclo[4.1.0]heptane, 3-methyl-	5859	041977-47-3	58
13	13.158	0.44	C:\Database\NIST05a.L			
			1,13-Tetradecadiene	52920	021964-49-8	68
			cis-9-Tetradecen-1-ol	65989	035153-15-2	62
			5-Undecyne	24365	002294-72-6	58
14	14.066	1.71	C:\Database\NIST05a.L			
			3-Undecene, (Z)-	25915	000821-97-6	93
			1-Undecene	25904	000821-95-4	93
			1-Undecene	25902	000821-95-4	93
15	14.749	1.33	C:\Database\NIST05a.L			
			Undecane	27239	001120-21-4	95
			Undecane	27238	001120-21-4	94
			Undecane	27236	001120-21-4	90
16	15.871	0.36	C:\Database\NIST05a.L			
			Cyclohexane, pentyl-	25939	004292-92-6	76
			n-Amylcyclohexane	25925	029949-27-7	72
			Cyclohexane, pentyl-	25936	004292-92-6	68
17	16.586	0.14	C:\Database\NIST05a.L			
			3,4-Octadiene, 7-methyl-	10330	037050-05-8	70
			3,4-Octadiene, 7-methyl-	10322	037050-05-8	58
			3-Octyne, 2-methyl-	10299	055402-15-8	49
18	17.024	0.38	C:\Database\NIST05a.L			
			Cyclohexene, 1-pentyl-	24388	015232-85-6	81
			1,11-Dodecadiene	33507	005876-87-9	59
			Cyclohexene,1-hexyl-	33523	003964-66-7	58
19	18.402	0.29	C:\Database\NIST05a.L			
			9-Octadecyne	92240	035365-59-4	72
			Bicyclo[3.1.1]heptane, 2,6,6-trime thyl-	16398	000473-55-2	58
			5-Undecyne	24356	002294-72-6	55
20	18.969	0.55	C:\Database\NIST05a.L			
			1,11-Dodecadiene	33507	005876-87-9	94
			1-Octadecyne	92236	000629-89-0	91
			Cyclododecene	33497	001501-82-2	86
21	20.079	1.89	C:\Database\NIST05a.L			
			1-Dodecene	34945	000112-41-4	96
			1-Dodecene	34944	000112-41-4	94
			Cyclododecane	34949	000294-62-2	91
22	20.849	1.88	C:\Database\NIST05a.L			
			Dodecane	36431	000112-40-3	96
			Dodecane	36429	000112-40-3	95
			Dodecane	36430	000112-40-3	95
23	22.130	0.16	C:\Database\NIST05a.L			
			Cyclohexane, hexyl-	34974	004292-75-5	76
			Cyclohexane, hexyl-	34975	004292-75-5	74
			1H-Pyrrole, 2,3-dihydro-1-methyl-	1290	033838-11-8	72

?k#	RT	Area%	Library/ID	Ref#	CAS#	Qual
24	22.440	0.24	C:\Database\NIST05a.L			
			6-Dodecene, (E)-	34971	007206-17-9	55
			Cyclopentane, (3-methylbutyl)-	17410	001005-68-1	52
			Cyclopentane, 1-pentyl-2-propyl-	44642	062199-51-3	49
25	23.060	0.35	C:\Database\NIST05a.L			
			1-Tridecene	44614	002437-56-1	90
			6-Tridecene, (Z)-	44628	006508-77-6	72
			9-Eicosyne	110846	071899-38-2	58
26	23.637	0.53	C:\Database\NIST05a.L			
			9-Methylbicyclo[3.3.1]nonane	16338	025107-01-1	53
			Cycloheptane, methyl-	6507	004126-78-7	38
			1-Cyclohexylheptene	43181	114614-83-4	38
27	24.726	0.27	C:\Database\NIST05a.L			
			1-Pentadecyne	63039	000765-13-9	59
			5-Eicosyne	110845	074685-31-7	58
			Dodeca-1,6-dien-12-ol, 6,10-dimeth yl-	64394	1000156-13-8	50
28	25.207	0.70	C:\Database\NIST05a.L			
			Bicyclo[3.3.2]decan-9-one	24079	028054-91-3	90
			trans-Decalin, 2-methyl-	24396	1000152-47-3	87
			5-Nonadecen-1-ol	113464	1000131-11-9	87
29	26.360	2.11	C:\Database\NIST05a.L			
			1-Tridecene	44618	002437-56-1	98
			1-Tridecene	44617	002437-56-1	97
			1-Tridecene	44614	002437-56-1	96
30	27.119	2.36	C:\Database\NIST05a.L			
			Tridecane	46086	000629-50-5	97
			Tridecane	46087	000629-50-5	97
			Tridecane	46084	000629-50-5	95
31	29.170	0.89	C:\Database\NIST05a.L			
			Cyclopentene, 1-octyl-	43184	052315-44-3	95
			3-Dodecyne	33484	006790-27-8	50
			Cyclopentene,1-(2-methylpropyl)-	10377	053098-47-8	43
32	29.779	0.22	C:\Database\NIST05a.L			
			Cyclohexasiloxane, dodecamethyl-	179152	000540-97-6	72
			Cyclohexasiloxane, dodecamethyl-	179153	000540-97-6	68
			Cyclohexasiloxane, dodecamethyl-	179151	000540-97-6	43
33	31.424	1.69	C:\Database\NIST05a.L			
			1,13-Tetradecadiene	52919	021964-49-8	91
			5-Nonadecen-1-ol	113464	1000131-11-9	90
			5-Cyclohexyl-1-pentene	24391	005729-54-4	83
34	32.577	2.43	C:\Database\NIST05a.L			
			2-Tetradecene, (E)-	54521	035953-53-8	98
			1-Tetradecene	54512	001120-36-1	96
			1-Tetradecene	54510	001120-36-1	94
35	33.314	2.78	C:\Database\NIST05a.L			
			Tetradecane	55975	000629-59-4	97

Pk#	RT	Area%	Library/ID	Ref#	CAS#	Qual
			Tetradecane	55972	000629-59-4	96
			Tetradecane	55973	000629-59-4	96
36	35.088	1.29	C:\Database\NIST05a.L			
			Cyclopentadecane	64458	000295-48-7	96
			Cyclotetradecane	54515	000295-17-0	95
			Cyclotetradecane	54517	000295-17-0	93
37	36.348	0.42	C:\Database\NIST05a.L			
			Cyclopropane, 1-butyl-2-pentyl-, cis-	35079	074663-88-0	41
			Cyclohexane, 1,1-dimethyl-	6568	000590-66-9	38
			Cyclopentane, (1-methylbutyl)-	17407	004737-43-3	38
38	37.395	1.33	C:\Database\NIST05a.L			
			1,12-Tridecadiene	43178	021964-48-7	91
			1,12-Tridecadiene	43179	021964-48-7	91
			11-Hexadecen-1-ol, (Z)-	85510	056683-54-6	83
39	38.506	2.62	C:\Database\NIST05a.L			
			1-Pentadecene	64454	013360-61-7	97
			1-Pentadecene	64457	013360-61-7	96
			1-Pentadecene	64455	013360-61-7	93
40	39.264	2.35	C:\Database\NIST05a.L			
			Pentadecane	66066	000629-62-9	97
			Pentadecane	66067	000629-62-9	95
			Pentadecane	66065	000629-62-9	94
41	39.969	0.96	C:\Database\NIST05a.L			
			Cyclopentane, 2-isopropyl-1,3-dimethyl-	17446	032281-85-9	70
			Cyclopentadecane	64459	000295-48-7	50
			Triallylmethylsilane	33364	001112-91-0	49
42	40.899	0.97	C:\Database\NIST05a.L			
			n-Nonylcyclohexane	64461	002883-02-5	64
			Heptylcyclohexane	44631	005617-41-4	64
			n-Nonylcyclohexane	64460	002883-02-5	64
43	41.785	0.58	C:\Database\NIST05a.L			
			Cyclohexene, 1-nonyl-	63043	015232-88-9	70
			1H-Indene, octahydro-5-methyl-	16347	019744-64-0	70
			Cyclohexene, 3-nonyl-	63042	015232-79-8	58
44	42.576	0.82	C:\Database\NIST05a.L			
			Cyclododecanemethanol	55891	001892-12-2	58
			Pentadecane, 3-methyl-	76102	002882-96-4	56
			Tetradecanal	65973	000124-25-4	52
45	43.088	0.97	C:\Database\NIST05a.L			
			1,15-Hexadecadiene	73063	021964-51-2	94
			1-Hexadecyne	73057	000629-74-3	93
			Z,Z-2,15-Octadecedien-1-ol acetate	129818	1000130-95-1	91
46	44.135	2.52	C:\Database\NIST05a.L			
			1-Hexadecene	74521	000629-73-2	99
			Z-8-Hexadecene	74523	1000130-87-5	98
			1-Hexadecene	74519	000629-73-2	96

Pk#	RT	Area%	Library/ID	Ref#	CAS#	Qual
47	44.883	2.80	C:\Database\NIST05a.L			
			Hexadecane	76091	000544-76-3	98
			Hexadecane	76092	000544-76-3	96
			Hexadecane	76093	000544-76-3	96
48	45.716	0.48	C:\Database\NIST05a.L			
			Oxalic acid, cyclohexylmethyl tetradecyl ester	165834	1000309-69-0	50
			Cyclohexadecane	74525	000295-65-8	46
			13-Oxabicyclo[10.1.0]tridecane	44556	000286-99-7	38
49	46.197	0.69	C:\Database\NIST05a.L			
			Cyclododecanemethanol	55891	001892-12-2	74
			1-Octadecanol	105754	000112-92-5	64
			1-Heptadecanol	96333	001454-85-9	64
50	46.710	1.68	C:\Database\NIST05a.L			
			Cyclohexadecane	74525	000295-65-8	96
			Z-8-Hexadecene	74523	1000130-87-5	91
			1-Docosene	129889	001599-67-3	90
51	48.558	1.48	C:\Database\NIST05a.L			
			1,19-Eicosadiene	110850	014811-95-1	81
			1,13-Tetradecadiene	52921	021964-49-8	76
			11-Hexadecen-1-ol, (Z)-	85510	056683-54-6	72
52	49.498	2.40	C:\Database\NIST05a.L			
			3-Heptadecene, (Z)-	84042	1000141-67-3	99
			E-14-Hexadecenal	83987	330207-53-9	99
			8-Heptadecene	84039	002579-04-6	95
53	50.203	2.90	C:\Database\NIST05a.L			
			Heptadecane	85525	000629-78-7	98
			Heptadecane	85523	000629-78-7	96
			Dodecane, 2,6,11-trimethyl-	66083	031295-56-4	93
54	51.100	0.68	C:\Database\NIST05a.L			
			Cyclopentadecane	64458	000295-48-7	95
			1-Octadecene	93544	000112-88-9	90
			Cyclotetradecane	54517	000295-17-0	83
55	51.549	0.78	C:\Database\NIST05a.L			
			Oxirane, tetradecyl-	85507	007320-37-8	62
			Cyclododecanemethanol	55891	001892-12-2	60
			1-Nonadecanol	114936	001454-84-8	50
56	52.104	0.96	C:\Database\NIST05a.L			
			Cyclopentane, (2-methylpropyl)-	11250	003788-32-7	52
			Tetradecanal	65973	000124-25-4	49
			Dichloroacetic acid, heptadecyl ester	159590	1000282-98-2	46
57	52.809	0.66	C:\Database\NIST05a.L			
			1H-Indene, octahydro-5-methyl-	16347	019744-64-0	60
			1,2-Diheptylcyclopropene	82657	035365-53-8	53
			1,2-Dioctylcyclopropene	101516	001089-40-3	49
58	53.183	0.40	C:\Database\NIST05a.L			

Pk#	RT	Area%	Library/ID	Ref#	CAS#	Qual
			Heptadecane, 3-methyl-	94941	006418-44-6	46
			2-Thiopheneacetic acid, 3,5-dimethylcyclohexyl ester	93158	1000278-92-2	43
			Carbonic acid, isobutyl octadecyl ester	161481	1000314-61-5	41
59	53.770	0.97	C:\Database\NIST05a.L			
			E-2-Octadecadecen-1-ol	104257	1000131-10-2	91
			1,13-Tetradecadiene	52921	021964-49-8	78
			1,19-Eicosadiene	110850	014811-95-1	76
60	54.593	2.26	C:\Database\NIST05a.L			
			1-Octadecene	93544	000112-88-9	99
			E-15-Heptadecenal	93518	1000130-97-9	99
			1-Nonadecene	102860	018435-45-5	95
61	55.287	3.66	C:\Database\NIST05a.L			
			Octadecane	94931	000593-45-3	98
			Octadecane	94930	000593-45-3	97
			Pentadecane	66065	000629-62-9	94
62	56.783	0.56	C:\Database\NIST05a.L			
			9-Octadecene, (E)-	93547	007206-25-9	95
			1-Pentadecanethiol	88046	025276-70-4	64
			(-)-trans-Pinane	16289	033626-25-4	46
63	57.274	0.76	C:\Database\NIST05a.L			
			3-Hexadecene, (Z)-	74526	034303-81-6	52
			Cyclohexane, (1-methylpropyl)-	17414	007058-01-7	46
			Cyclohexane, (1,3-dimethylbutyl)-	35070	061142-19-6	43
64	58.620	2.06	C:\Database\NIST05a.L			
			Cyclododecanemethanol	55891	001892-12-2	80
			E-2-Octadecadecen-1-ol	104257	1000131-10-2	64
			1,19-Eicosadiene	110850	014811-95-1	62
65	59.432	1.95	C:\Database\NIST05a.L			
			Z-5-Nonadecene	102861	1000131-11-8	99
			1-Nonadecene	102860	018435-45-5	95
			1-Nonadecene	102859	018435-45-5	94
66	60.083	3.09	C:\Database\NIST05a.L			
			Nonadecane	104271	000629-92-5	96
			Nonadecane	104272	000629-92-5	96
			Heptadecane	85523	000629-78-7	94
67	61.141	1.25	C:\Database\NIST05a.L			
			5-Eicosene, (E)-	112105	074685-30-6	98
			Z-5-Nonadecene	102861	1000131-11-8	96
			1-Nonadecene	102858	018435-45-5	96
68	62.134	1.30	C:\Database\NIST05a.L			
			Decane, 2-cyclohexyl-	74534	013151-73-0	55
			n-Amylcyclohexane	25925	029949-27-7	49
			Cyclohexane, pentyl-	25940	004292-92-6	47
69	64.046	3.10	C:\Database\NIST05a.L			
			Cycloeicosane	112104	000296-56-0	98
			1-Eicosene	112103	003452-07-1	96

k#	RT	Area%	Library/ID	Ref#	CAS#	Qual
			E-15-Heptadecenal	93518	1000130-97-9	96
70	64.687	2.05	C:\Database\NIST05a.L			
			Eicosane	113492	000112-95-8	99
			Octadecane	94930	000593-45-3	95
			Eicosane	113489	000112-95-8	93
71	65.072	0.91	C:\Database\NIST05a.L			
			5-Eicosene, (E)-	112105	074685-30-6	70
			1-Nonadecene	102860	018435-45-5	64
			9-Tricosene, (Z)-	138118	027519-02-4	62
72	66.311	2.09	C:\Database\NIST05a.L			
			9-Tricosene, (Z)-	138119	027519-02-4	96
			Z-5-Nonadecene	102861	1000131-11-8	95
			9-Tricosene, (Z)-	138118	027519-02-4	95
73	67.465	2.75	C:\Database\NIST05a.L			
			Octadecane	94930	000593-45-3	95
			1-Octadecene	93544	000112-88-9	90
			Hexadecane, 2,6,10,14-tetramethyl-	113507	000638-36-8	87
74	68.437	1.58	C:\Database\NIST05a.L			
			Z-5-Nonadecene	102861	1000131-11-8	99
			1-Nonadecene	102860	018435-45-5	97
			9-Tricosene, (Z)-	138118	027519-02-4	96
75	69.056	2.97	C:\Database\NIST05a.L			
			Heneicosane	122435	000629-94-7	99
			Heneicosane	122436	000629-94-7	96
			Octadecane	94930	000593-45-3	95
76	70.285	1.74	C:\Database\NIST05a.L			
			1-Tricosene	138116	018835-32-0	99
			9-Tricosene, (Z)-	138119	027519-02-4	93
			5-Eicosene, (E)-	112105	074685-30-6	89
77	71.257	1.03	C:\Database\NIST05a.L			
			3-(4,8,12-Trimethyltridecyl) furan	119921	1000245-55-1	83
			Undecane, 2-cyclohexyl-	84051	013151-77-4	70
			Decane, 2-cyclohexyl-	74534	013151-73-0	55

Plastic Wrapper

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Operator   : ALI
Acquired   : 23 Feb 2016  20:03     using AcqMethod LIQUID FUEL.M
Instrument :    GCMSD
Sample Name: PLASTIC KEIH
Misc Info  :
Vial Number: 5
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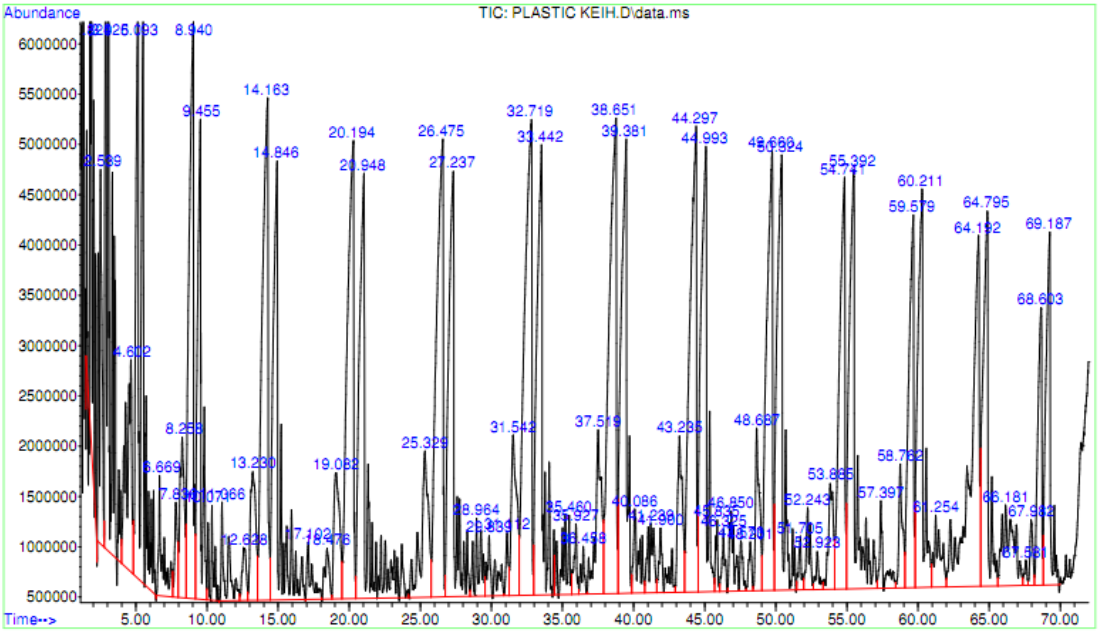

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1	1.824	2.04	C:\Database\NIST05a.L			
			1-Heptene	3229	000592-76-7	93
			2-Hexene, 5-methyl-, (E)-	3310	007385-82-2	55
			1-Heptene	3228	000592-76-7	55
2	2.540	1.29	C:\Database\NIST05a.L			
			Cyclohexene, 4-methyl-	2816	000591-47-9	70
			Cyclohexene, 1-methyl-	2812	000591-49-1	62
			Cyclohexane, methylene-	2823	001192-37-6	58
3	3.031	3.24	C:\Database\NIST05a.L			
			Octane	7421	000111-65-9	87
			Heptane, 2,4-dimethyl-	12289	002213-23-2	72
			Heptane, 2,4-dimethyl-	12300	002213-23-2	72
4	4.601	1.31	C:\Database\NIST05a.L			
			Styrene	4752	000100-42-5	59
			Styrene	4751	000100-42-5	59
			Bicyclo[4.2.0]octa-1,3,5-triene	4759	000694-87-1	44
5	5.093	3.74	C:\Database\NIST05a.L			
			1-Nonene	11144	000124-11-8	93
			Cyclopropane, 1-methyl-2-pentyl-	11252	041977-37-1	91
			1-Nonene	11145	000124-11-8	90
6	6.674	0.51	C:\Database\NIST05a.L			
			Cyclopentene, 1-butyl-	10315	002423-01-0	74
			Cyclopentene, 1-pentyl-	16315	004291-98-9	50
			Cyclopentene, 1-pentyl-	16319	004291-98-9	50
7	7.838	0.30	C:\Database\NIST05a.L			
			1-Ethyl-5-methylcyclopentene	5833	097797-57-4	50
			Cyclohexane, ethenyl-	5781	000695-12-5	46
			Methyl ethyl cyclopentene	5808	019780-56-4	43
8	8.254	0.85	C:\Database\NIST05a.L			
			1,11-Dodecadiene	33507	005876-87-9	58
			1,11-Dodecadiene	33506	005876-87-9	50
			3-Decen-1-ol, (E)-	27054	010339-60-3	47
9	8.938	2.97	C:\Database\NIST05a.L			
			1-Decene	17321	000872-05-9	98
			1-Decene	17320	000872-05-9	97
			1-Decene	17319	000872-05-9	94
10	9.451	2.11	C:\Database\NIST05a.L			
			Decane	18487	000124-18-5	95
			Decane	18485	000124-18-5	95
			Decane	18488	000124-18-5	94
11	10.070	0.33	C:\Database\NIST05a.L			
			2-Methylbicyclo[3.2.1]octane	10344	1000215-28-0	76
			Cyclopentane, pentylidene-	16329	053366-55-5	68
			3-Cyclopentylcyclopentene	15213	002690-17-7	64
12	11.064	0.47	C:\Database\NIST05a.L			
			Cyclopentene, 1-pentyl-	16319	004291-98-9	72
			Naphthalene, decahydro-	16321	000091-17-8	68
			Cyclodecene	16279	003618-12-0	64

Pk#	RT	Area%	Library/ID	Ref#	CAS#	Qual
13	12.623	0.25	C:\Database\NIST05a.L			
			Naphthalene, decahydro-2-methyl-	24413	002958-76-1	72
			cis-Decalin, 2-syn-methyl-	24400	1000155-85-6	64
			1,8-Nonadiene, 2,8-dimethyl-	24402	020054-25-5	64
14	13.232	0.81	C:\Database\NIST05a.L			
			1,13-Tetradecadiene	52920	021964-49-8	74
			5-Undecyne	24365	002294-72-6	62
			11,14-Eicosadienoic acid, methyl e ster	138089	002463-02-7	58
15	14.162	3.34	C:\Database\NIST05a.L			
			1-Undecene	25902	000821-95-4	95
			3-Undecene, (Z)-	25915	000821-97-6	93
			1-Undecene	25904	000821-95-4	93
16	14.845	2.95	C:\Database\NIST05a.L			
			Undecane	27239	001120-21-4	95
			Undecane	27238	001120-21-4	94
			Undecane	27240	001120-21-4	87
17	17.099	0.29	C:\Database\NIST05a.L			
			Cyclohexene, 1-pentyl-	24388	015232-85-6	58
			Cyclohexene, 3-pentyl-	24389	015232-92-5	52
			Cyclohexene,1-hexyl-	33523	003964-66-7	52
18	18.477	0.26	C:\Database\NIST05a.L			
			5-Undecyne	24356	002294-72-6	60
			Bicyclo[3.1.1]heptane, 2,6,6-trime thyl-	16398	000473-55-2	58
			(-)-trans-Pinane	16289	033626-25-4	53
19	19.086	0.84	C:\Database\NIST05a.L			
			1,11-Dodecadiene	33507	005876-87-9	95
			1,11-Dodecadiene	33506	005876-87-9	90
			Cyclododecene	33497	001501-82-2	86
20	20.197	3.33	C:\Database\NIST05a.L			
			1-Dodecene	34945	000112-41-4	96
			1-Dodecene	34944	000112-41-4	94
			Cyclodecane	17324	000293-96-9	91
21	20.945	3.43	C:\Database\NIST05a.L			
			Dodecane	36431	000112-40-3	96
			Dodecane	36430	000112-40-3	95
			Dodecane	36429	000112-40-3	95
22	25.324	1.23	C:\Database\NIST05a.L			
			1-Heptadecyne	82655	026186-00-5	90
			cis-9-Tetradecen-1-ol	65989	035153-15-2	86
			Bicyclo[3.3.2]decan-9-one	24079	028054-91-3	81
23	26.478	3.50	C:\Database\NIST05a.L			
			1-Tridecene	44618	002437-56-1	98
			1-Tridecene	44617	002437-56-1	97
			1-Tridecene	44614	002437-56-1	96
24	27.236	2.94	C:\Database\NIST05a.L			

Pk#	RT	Area%	Library/ID	Ref#	CAS#	Qual
			Tridecane	46084	000629-50-5	96
			Tridecane	46086	000629-50-5	95
			Tridecane	46085	000629-50-5	95
25	28.967	0.43	C:\Database\NIST05a.L			
			Cyclotridecane	44619	000295-02-3	64
			4-Nonene, 5-butyl-	44632	007367-38-6	58
			Cyclotetradecane	54513	000295-17-0	58
26	29.843	0.41	C:\Database\NIST05a.L			
			Cyclohexasiloxane, dodecamethyl-	179152	000540-97-6	81
			Cyclohexasiloxane, dodecamethyl-	179153	000540-97-6	68
			Cyclohexasiloxane, dodecamethyl-	179151	000540-97-6	43
27	31.114	0.16	C:\Database\NIST05a.L			
			1-Pentadecyne	63039	000765-13-9	80
			1-Hexadecyne	73057	000629-74-3	58
			2,6-Dimethylbicyclo[3.2.1]octane	16365	1000215-28-2	58
28	31.541	1.01	C:\Database\NIST05a.L			
			1,13-Tetradecadiene	52919	021964-49-8	91
			5-Cyclohexyl-1-pentene	24391	005729-54-4	83
			cis-7-Dodecen-1-yl acetate	75866	014959-86-5	72
29	32.716	3.92	C:\Database\NIST05a.L			
			2-Tetradecene, (E)-	54521	035953-53-8	98
			1-Tetradecene	54512	001120-36-1	96
			1-Tetradecene	54508	001120-36-1	95
30	33.443	3.07	C:\Database\NIST05a.L			
			Tetradecane	55975	000629-59-4	97
			Tetradecane	55972	000629-59-4	96
			Tetradecane	55973	000629-59-4	96
31	35.461	0.54	C:\Database\NIST05a.L			
			Cyclopentene, 1-octyl-	43184	052315-44-3	53
			3-Octyne, 2-methyl-	10299	055402-15-8	52
			Cyclopentene,1-heptyl-	33526	004292-00-6	50
32	35.931	0.22	C:\Database\NIST05a.L			
			Cyclohexene, 1-octyl-	52924	015232-87-8	87
			Cyclohexene,1-hexyl-	33523	003964-66-7	76
			Cyclohexene, 3-octyl-	52925	015232-94-7	68
33	36.455	0.16	C:\Database\NIST05a.L			
			Cyclopentane, 1,2-dimethyl-3-(1-methylethyl)-	17461	000489-20-3	52
			Cyclopropane, 1-butyl-2-pentyl-, cis-	35079	074663-88-0	46
			Cyclooctane, 1,5-dimethyl-	17397	021328-57-4	43
34	37.523	1.10	C:\Database\NIST05a.L			
			1,13-Tetradecadiene	52919	021964-49-8	90
			1,12-Tridecadiene	43178	021964-48-7	89
			1,13-Tetradecadiene	52920	021964-49-8	87
35	38.655	3.95	C:\Database\NIST05a.L			
			1-Pentadecene	64454	013360-61-7	97
			1-Pentadecene	64457	013360-61-7	96

?k#	RT	Area%	Library/ID	Ref#	CAS#	Qual
			1-Pentadecene	64455	013360-61-7	93
36	39.382	3.04	C:\Database\NIST05a.L			
			Pentadecane	66066	000629-62-9	97
			Pentadecane	66067	000629-62-9	96
			Pentadecane	66065	000629-62-9	94
37	40.087	0.48	C:\Database\NIST05a.L			
			Cyclopentane, 2-isopropyl-1,3-dimethyl-	17446	032281-85-9	64
			Cycloheptane, methyl-	6515	004126-78-7	46
			Cyclohexanemethanol	7280	000100-49-2	43
38	41.240	0.47	C:\Database\NIST05a.L			
			Cyclohexadecane	74525	000295-65-8	95
			Cyclotetradecane	54515	000295-17-0	87
			3-Hexadecene, (Z)-	74526	034303-81-6	70
39	41.903	0.41	C:\Database\NIST05a.L			
			Cyclohexene, 3-nonyl-	63042	015232-79-8	76
			Cyclohexene, 1-nonyl-	63043	015232-88-9	70
			Bicyclo[4.1.0]heptane, 2-methyl-7-pentyl-	43210	055937-92-3	53
40	43.238	0.83	C:\Database\NIST05a.L			
			1,15-Hexadecadiene	73063	021964-51-2	95
			1,13-Tetradecadiene	52919	021964-49-8	90
			11-Hexadecen-1-ol, (Z)-	85510	056683-54-6	87
41	44.295	3.49	C:\Database\NIST05a.L			
			1-Hexadecene	74521	000629-73-2	99
			Z-8-Hexadecene	74523	1000130-87-5	98
			1-Hexadecene	74519	000629-73-2	96
42	44.990	3.08	C:\Database\NIST05a.L			
			Hexadecane	76091	000544-76-3	98
			Hexadecane	76093	000544-76-3	98
			Hexadecane	76092	000544-76-3	97
43	45.834	0.17	C:\Database\NIST05a.L			
			Oxalic acid, cyclohexylmethyl propyl ester	76956	1000309-68-1	50
			cis-11-Hexadecenal	83994	053939-28-9	47
			9-Tetradecenal, (Z)-	64377	053939-27-8	47
44	46.325	0.20	C:\Database\NIST05a.L			
			(-)-trans-Pinane	16289	033626-25-4	58
			Bicyclo[3.1.1]heptane, 2,6,6-trimethyl-	16406	000473-55-2	52
			1,15-Hexadecadiene	73063	021964-51-2	49
45	46.848	0.41	C:\Database\NIST05a.L			
			Cyclohexadecane	74525	000295-65-8	95
			Cyclohexadecane	74524	000295-65-8	93
			Cyclopentadecane	64458	000295-48-7	91
46	47.575	0.16	C:\Database\NIST05a.L			
			1-Pentadecyne	63039	000765-13-9	49
			6-Methyloctahydrocoumarin	34575	080648-29-9	46

Pk#	RT	Area%	Library/ID	Ref#	CAS#	Qual
			1H-Indene, octahydro-5-methyl-	16347	019744-64-0	46
47	48.205	0.16	C:\Database\NIST05a.L			
			Cyclohexane, 1-(cyclohexylmethyl)-3-methyl-, trans-	52955	054823-95-9	74
			Cyclohexane, 1-(cyclohexylmethyl)-4-methyl-, cis-	52953	054823-97-1	68
			Tetradecanenitrile	63714	000629-63-0	62
48	48.686	0.72	C:\Database\NIST05a.L			
			1,13-Tetradecadiene	52921	021964-49-8	90
			1,13-Tetradecadiene	52919	021964-49-8	89
			cis-11-Tetradecen-1-ol	65996	034010-15-6	86
49	49.658	3.01	C:\Database\NIST05a.L			
			3-Heptadecene, (Z)-	84042	1000141-67-3	99
			E-14-Hexadecenal	83987	330207-53-9	99
			8-Heptadecene	84040	054290-12-9	96
50	50.320	3.04	C:\Database\NIST05a.L			
			Heptadecane	85525	000629-78-7	97
			Heptadecane	85523	000629-78-7	96
			Dodecane, 2,6,11-trimethyl-	66083	031295-56-4	93
51	51.709	0.16	C:\Database\NIST05a.L			
			Bicyclo[3.1.1]heptane, 2,6,6-trimethyl-	16406	000473-55-2	70
			Tridecanedial	65765	063521-76-6	70
			(-)-trans-Pinane	16289	033626-25-4	58
52	52.243	0.34	C:\Database\NIST05a.L			
			trans-Undec-4-enal	34846	068820-35-9	64
			Cyclopentane, decyl-	64463	001795-21-7	60
			Dichloroacetic acid, heptadecyl ester	159590	1000282-98-2	50
53	52.926	0.14	C:\Database\NIST05a.L			
			1H-Indene, octahydro-5-methyl-	16347	019744-64-0	50
			(4-Methyl-pent-3-enyl)-cyclohexane	33544	1000185-19-1	42
			(R)-(-)-(Z)-14-Methyl-8-hexadecen-1-ol	94911	030689-78-2	42
54	53.888	0.61	C:\Database\NIST05a.L			
			cis-9-Tetradecen-1-ol	65989	035153-15-2	90
			1,19-Eicosadiene	110850	014811-95-1	90
			1,13-Tetradecadiene	52921	021964-49-8	89
55	54.742	2.61	C:\Database\NIST05a.L			
			1-Octadecene	93544	000112-88-9	99
			E-15-Heptadecenal	93518	1000130-97-9	99
			1-Nonadecene	102860	018435-45-5	95
56	55.394	3.08	C:\Database\NIST05a.L			
			Octadecane	94931	000593-45-3	98
			Pentadecane	66065	000629-62-9	94
			Octadecane	94930	000593-45-3	94
57	57.402	0.38	C:\Database\NIST05a.L			
			1-Nonadecene	102859	018435-45-5	72

k#	RT	Area%	Library/ID	Ref#	CAS#	Qual
			Cyclohexane, (1,3-dimethylbutyl)-	35070	061142-19-6	46
			9-Octadecene, (E)-	93547	007206-25-9	38
58	58.759	0.50	C:\Database\NIST05a.L			
			Z,Z-2,15-Octadecedien-1-ol acetate	129818	1000130-95-1	89
			1,15-Hexadecadiene	73063	021964-51-2	86
			1,19-Eicosadiene	110850	014811-95-1	81
59	59.581	2.11	C:\Database\NIST05a.L			
			Z-5-Nonadecene	102861	1000131-11-8	99
			1-Nonadecene	102860	018435-45-5	95
			1-Nonadecene	102859	018435-45-5	94
60	60.212	2.52	C:\Database\NIST05a.L			
			Nonadecane	104271	000629-92-5	96
			Nonadecane	104272	000629-92-5	95
			Heptadecane	85523	000629-78-7	94
61	61.258	0.49	C:\Database\NIST05a.L			
			1-Nonadecene	102858	018435-45-5	98
			Z-5-Nonadecene	102861	1000131-11-8	96
			Cyclotetracosane	145923	000297-03-0	95
62	64.196	3.42	C:\Database\NIST05a.L			
			E-15-Heptadecenal	93518	1000130-97-9	98
			Cycloeicosane	112104	000296-56-0	98
			1-Octadecene	93544	000112-88-9	97
63	64.794	2.28	C:\Database\NIST05a.L			
			Eicosane	113492	000112-95-8	99
			Octadecane	94930	000593-45-3	95
			Eicosane	113490	000112-95-8	94
64	66.183	1.01	C:\Database\NIST05a.L			
			1-Octadecene	93544	000112-88-9	70
			Pentacosane	153747	000629-99-2	53
			Octadecanal	104240	000638-66-4	50
65	67.582	0.08	C:\Database\NIST05a.L			
			1-Docosene	129889	001599-67-3	94
			9-Tricosene, (Z)-	138119	027519-02-4	91
			1-Heptadecene	84041	006765-39-5	53
66	67.977	0.21	C:\Database\NIST05a.L			
			Oxirane, hexadecyl-	104255	007390-81-0	95
			(R)-(-)-(Z)-14-Methyl-8-hexadecen-1-ol	94911	030689-78-2	86
			1,13-Tetradecadiene	52921	021964-49-8	78
67	68.608	1.26	C:\Database\NIST05a.L			
			Z-5-Nonadecene	102861	1000131-11-8	99
			1-Nonadecene	102860	018435-45-5	97
			10-Heneicosene (c,t)	121168	095008-11-0	96
68	69.184	1.85	C:\Database\NIST05a.L			
			Heneicosane	122435	000629-94-7	99
			Heneicosane	122436	000629-94-7	95
			Tetratriacontane	182859	014167-59-0	91

Polystyrene

```
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Operator   : ALI
Acquired   : 23 Feb 2016  18:45     using AcqMethod LIQUID FUEL.M
Instrument :    GCMSD
Sample Name: FOOD CONTAINER PS
Misc Info  :
Vial Number: 4
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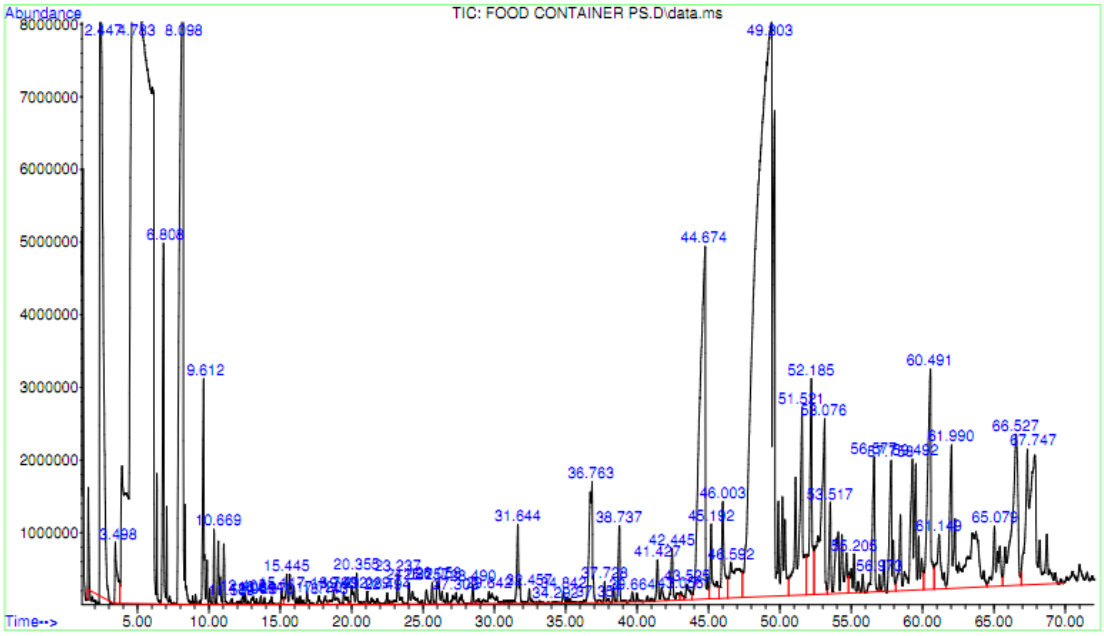

Pk#	RT	Area%	Library/ID	Ref#	CAS#	Qual
1	2.444	4.90	C:\Database\NIST05a.L			
			Toluene	2395	000108-88-3	95
			Toluene	2400	000108-88-3	93
			Toluene	2397	000108-88-3	91
2	3.501	0.34	C:\Database\NIST05a.L			
			Cyclotrisiloxane, hexamethyl-	73123	000541-05-9	83
			Cyclotrisiloxane, hexamethyl-	73121	000541-05-9	80
			Cyclotrisiloxane, hexamethyl-	73122	000541-05-9	59
3	4.783	29.88	C:\Database\NIST05a.L			
			Styrene	4749	000100-42-5	97
			Styrene	4751	000100-42-5	96
			Bicyclo[4.2.0]octa-1,3,5-triene	4759	000694-87-1	96
4	6.813	1.29	C:\Database\NIST05a.L			
			Benzaldehyde	4937	000100-52-7	95
			Benzaldehyde	4936	000100-52-7	90
			Benzene, 2-propenyl-	8682	000300-57-2	70
5	8.094	5.50	C:\Database\NIST05a.L			
			.alpha.-Methylstyrene	8689	000098-83-9	96
			.alpha.-Methylstyrene	8693	000098-83-9	93
			.alpha.-Methylstyrene	8692	000098-83-9	93
6	9.611	0.83	C:\Database\NIST05a.L			
			Benzene, 1-propenyl-	8683	000637-50-3	92
			Benzene, cyclopropyl-	8691	000873-49-4	89
			Benzene, 2-propenyl-	8684	000300-57-2	76
7	10.669	0.54	C:\Database\NIST05a.L			
			Acetophenone	9076	000098-86-2	91
			Acetophenone	9074	000098-86-2	91
			Acetophenone	9078	000098-86-2	91
8	11.587	0.02	C:\Database\NIST05a.L			
			Benzene, (1,1-dimethylethoxy)-	22783	006669-13-2	45
			n-Pentylpyrazine	23571	006303-75-9	38
			Benzene, butoxy-	22712	001126-79-0	38
9	12.410	0.09	C:\Database\NIST05a.L			
			Oxirane, 2-methyl-2-phenyl-	14824	002085-88-3	95
			Benzeneacetaldehyde, .alpha.-methy l-	14863	000093-53-8	94
			Benzeneacetaldehyde, .alpha.-methy l-	14861	000093-53-8	90
10	13.072	0.06	C:\Database\NIST05a.L			
			Triquinacene	12676	006053-74-3	96
			Tetracyclo[5.3.0.0<2,6>.0<3,10>]de ca-4,8-diene	12715	034324-40-8	93
			Benzene, (1-methylene-2-propenyl)-	12706	002288-18-8	83
11	13.649	0.04	C:\Database\NIST05a.L			
			1-Undecene	25902	000821-95-4	91
			3-Tetradecene, (E)-	54530	041446-68-8	80
			3-Undecene, (Z)-	25907	000821-97-6	64
12	14.375	0.03	C:\Database\NIST05a.L			

k#	RT	Area%	Library/ID	Ref#	CAS#	Qual
			Benzene, 2-butenyl-	13594	001560-06-1	96
			Benzene, 1-butenyl-, (E)-	13605	001005-64-7	95
			Benzene, (2-methyl-1-propenyl)-	13620	000768-49-0	95
13	15.112	0.05	C:\Database\NIST05a.L			
			2-Phenylpropenal	14059	004432-63-7	80
			1H-Inden-1-one, 2,3-dihydro-	14079	000083-33-0	46
			3-Phenyl-1-aza-bicyclo[1.1.0]butan	13574	017945-94-7	38
14	15.444	0.40	C:\Database\NIST05a.L			
			Benzene, (1-ethyl-2-propenyl)-	20808	019947-22-9	93
			Benzene, (1-methylenebutyl)-	20794	005676-32-4	91
			Benzene, (1-methylenebutyl)-	20795	005676-32-4	90
15	17.719	0.04	C:\Database\NIST05a.L			
			Benzene,2-cyclopenten-1-yl-	19677	037689-22-8	95
			Benzene, 1-cyclopenten-1-yl-	19678	000825-54-7	91
			Benzene, (2-cyclopropylethenyl)-	19684	1000142-01-6	87
16	18.146	0.04	C:\Database\NIST05a.L			
			1H-Indene, 1-ethenyl-2,3-dihydro-	19686	051783-46-1	95
			Naphthalene, 1,2-dihydro-6-methyl-	19689	002717-47-7	90
			1H-Indene, 4,7-dimethyl-	19672	006974-97-6	81
17	18.755	0.12	C:\Database\NIST05a.L			
			Cyclopentasiloxane, decamethyl-	161015	000541-02-6	93
			Cyclopentasiloxane, decamethyl-	161017	000541-02-6	81
			Cyclopentasiloxane, decamethyl-	161016	000541-02-6	74
18	19.492	0.08	C:\Database\NIST05a.L			
			1-Dodecene	34944	000112-41-4	92
			Cyclododecane	34948	000294-62-2	64
			1-Undecanol	37772	000112-42-5	52
19	20.357	0.22	C:\Database\NIST05a.L			
			Benzene, 1-hexynyl-	28442	001129-65-3	90
			1-Phenylbicyclo[2.1.1]hexane	28463	029508-78-9	50
			1,2,3-Trimethylindene	28444	004773-83-5	46
20	21.094	0.11	C:\Database\NIST05a.L			
			Benzene, (1-methylenepentyl)-	29533	020826-80-6	87
			1,3-Propanediol, 2-methyl-2-phenyl	33222	024765-53-5	72
			Hex-1-ene,2,5-diphenyl-	82663	032375-29-4	64
21	22.494	0.06	C:\Database\NIST05a.L			
			Benzene, hexyl-	30794	001077-16-3	42
			Benzene, hexyl-	30792	001077-16-3	42
			Benzene, hexyl-	30795	001077-16-3	38
22	23.241	0.16	C:\Database\NIST05a.L			
			Benzene, 3,5-hexadienyl-	28452	039669-95-9	50
			1H-Imidazole, 1-(phenylmethyl)-	28311	004238-71-5	43
			1H-Imidazole, 1-(phenylmethyl)-	28310	004238-71-5	43
23	24.032	0.18	C:\Database\NIST05a.L			
			Benzene,2-cyclopenten-1-yl-	19677	037689-22-8	97
			Benzene, 1-cyclopenten-1-yl-	19681	000825-54-7	94
			Benzene, 1-cyclopenten-1-yl-	19678	000825-54-7	94

Pk#	RT	Area%	Library/ID	Ref#	CAS#	Qual
24	25.260	0.13	C:\Database\NIST05a.L			
			Benzene, 3-heptynyl-	37870	056293-04-0	47
			1H-Imidazole, 1-(phenylmethyl)-	28304	004238-71-5	43
			3-Benzyl-4-bromo-1,2,3-triazole 1-oxide	94159	1000099-47-9	38
25	26.061	0.22	C:\Database\NIST05a.L			
			Hexa-2,4-dienylbenzene	28445	079482-86-3	83
			Benzene, 1,3-hexadienyl-	28454	041635-77-2	78
			Benzene, 1,3-hexadienyl-	28453	041635-77-2	60
26	27.301	0.14	C:\Database\NIST05a.L			
			(4-Methyl-1-methylenepent-4-enyl)benzene	37880	063942-88-1	43
			1-Phenyl-1-heptyne	37867	014374-45-9	43
			1H-Indene, 1-methyl-3-propyl-	37876	111400-83-0	38
27	28.486	0.07	C:\Database\NIST05a.L			
			Biphenyl	25992	000092-52-4	91
			Biphenyl	25990	000092-52-4	76
			Naphthalene, 2-ethenyl-	25997	000827-54-3	74
28	29.640	0.21	C:\Database\NIST05a.L			
			Cyclohexasiloxane, dodecamethyl-	179152	000540-97-6	91
			Cyclohexasiloxane, dodecamethyl-	179153	000540-97-6	86
			Cyclohexasiloxane, dodecamethyl-	179151	000540-97-6	83
29	31.648	0.41	C:\Database\NIST05a.L			
			Diphenylmethane	35105	000101-81-5	96
			Diphenylmethane	35102	000101-81-5	95
			Diphenylmethane	35104	000101-81-5	94
30	32.460	0.08	C:\Database\NIST05a.L			
			Tetradecane	55975	000629-59-4	98
			Tetradecane	55972	000629-59-4	98
			Tetradecane	55974	000629-59-4	95
31	34.297	0.01	C:\Database\NIST05a.L			
			Pentacyclo[7.5.0.0(2,7).0(3,5).0(4,8)]tetradeca-10,12-diene	46199	088056-67-1	25
			4-Pentadecyne, 15-chloro-	86735	056554-70-2	25
			Cyclopentane, ethylidene-	2844	002146-37-4	25
32	34.842	0.08	C:\Database\NIST05a.L			
			1,1'-Biphenyl, 3-methyl-	35109	000643-93-6	96
			1,1'-Biphenyl, 3-methyl-	35115	000643-93-6	94
			1,1'-Biphenyl, 4-methyl-	35117	000644-08-6	94
33	36.765	0.94	C:\Database\NIST05a.L			
			Benzene, 1,1'-(1,2-ethanediyl)bis-	44683	000103-29-7	58
			Benzene, 1,1'-(1,2-ethanediyl)bis-	44685	000103-29-7	50
			Benzene, 1,1'-(1,2-ethanediyl)bis-	44684	000103-29-7	50
34	37.352	0.02	C:\Database\NIST05a.L			
			5-Methyl-1-phenylbicyclo[3.2.0]heptane	47525	1000217-30-9	49
			7-Phenylbicyclo[3.2.0]heptan-6-one	47500	073788-97-3	42
			1,6-Heptadiene, 2-methyl-6-phenyl-	47522	051708-97-5	30

Pk#	RT	Area%	Library/ID	Ref#	CAS#	Qual
35	37.726	0.08	C:\Database\NIST05a.L			
			1-Pentadecene	64457	013360-61-7	98
			2-Tetradecene, (E)-	54521	035953-53-8	91
			5-Octadecene, (E)-	93546	007206-21-5	91
36	38.741	0.34	C:\Database\NIST05a.L			
			Benzene, 1,1'-(1-methyl-1,2-ethanediyl)bis-	54595	005814-85-7	90
			Benzene, 1,1'-(1-methyl-1,2-ethanediyl)bis-	54594	005814-85-7	90
			3-Phenylbutyric acid	31725	004593-90-2	59
37	39.660	0.07	C:\Database\NIST05a.L			
			.alpha.-Methylstilbene	52962	000779-51-1	95
			Stilbene, .alpha.-methyl-, (E)-	52969	000833-81-8	94
			N-(4-Methoxyphenyl)-2-hydroxyimino-acetamide	53297	1000143-61-3	90
38	41.422	0.26	C:\Database\NIST05a.L			
			.alpha.-Methylstilbene	52962	000779-51-1	91
			Phenanthrene, 9,10-dihydro-1-methyl-	52975	095676-48-5	68
			Anthracene, 9,10-dihydro-2-methyl-	52971	000948-67-4	60
39	42.448	0.28	C:\Database\NIST05a.L			
			Borinic acid, diethyl-, 1-phenyl-1-propenyl ester	58461	034602-33-0	72
			Benzene, (1-ethyl-2-propenyl)-	20800	019947-22-9	64
			Benzene, 1,1'-(1-butene-1,4-diyl)bis-, (Z)-	63107	070388-65-7	64
40	43.056	0.04	C:\Database\NIST05a.L			
			Cyclohexane, 1-phenyl-3,4-divinyl-, (1R,3trans,4trans)-	66109	1000160-00-5	91
			Cyclohexane, 1-phenyl-3,4-divinyl-, (1R,3cis,4cis)-	66106	1000160-00-6	41
			Benzenepropanoic acid, ethyl ester	41456	002021-28-5	38
41	43.526	0.13	C:\Database\NIST05a.L			
			1-Hexadecene	74521	000629-73-2	96
			1-Nonadecene	102860	018435-45-5	93
			1-Docosene	129889	001599-67-3	81
42	44.669	4.48	C:\Database\NIST05a.L			
			Benzene, 1,1'-(1,3-propanediyl)bis	54576	001081-75-0	97
			Benzene, 1,1'-(1,3-propanediyl)bis	54578	001081-75-0	97
			Benzene, 1,1'-(1,3-propanediyl)bis	54579	001081-75-0	96
43	45.193	0.44	C:\Database\NIST05a.L			
			1,2-Diphenylcyclopropane	52963	029881-14-9	97
			N-(4-Methoxyphenyl)-2-hydroxyimino-acetamide	53297	1000143-61-3	90
			Benzene, 1,1'-cyclopropylidenebis-	52974	003282-18-6	87
44	46.005	0.60	C:\Database\NIST05a.L			
			Benzene, 1,1'-(1-methyl-1,3-propanediyl)bis-	64493	001520-44-1	93
			Benzene, 1,1'-(3-methyl-1-propene-1,3-diyl)bis-	63118	007614-93-9	64

Pk#	RT	Area%	Library/ID	Ref#	CAS#	Qual
			Benzene, 1,1'-(1,2-dimethyl-1,2-et henediyl)bis-, (E)-	63120	000782-06-9	62
45	46.592	0.80	C:\Database\NIST05a.L			
			Benzene, 1,1'-[1-(2-propenyl)-1,2- ethanediyl]bis-	73097	005729-55-5	96
			9-Methyl-9H-carbazole	43890	027323-29-1	30
			1-Methylsulfonyl-1,2-diphenylethan	98651	015733-05-8	30
46	49.305	23.65	C:\Database\NIST05a.L			
			N-Benzyl-1H-benzimidazole	62907	004981-92-4	27
			Benzene, (3-nitropropyl)-	32997	022818-69-5	27
			3-Benzyl-4-bromo-1,2,3-triazole 1- oxide	94159	1000099-47-9	22
47	51.517	1.97	C:\Database\NIST05a.L			
			2,3-Diazabicyclo[2.2.1]hept-2-ene, 1,4-diphenyl-	90805	106230-80-2	87
			1-(4-Methylphenyl)-4-phenylbuta-1, 3-diene	71521	037985-11-8	62
			Furan, 2,5-diphenyl-	71477	000955-83-9	38
48	52.190	1.25	C:\Database\NIST05a.L			
			Benzene, 1,1'-(3-methyl-1-propene- 1,3-diyl)bis-	63118	007614-93-9	89
			Benzene, 1,1'-(1-butenylidene)bis-	63092	001726-14-3	86
			Benzene, 1,1'-(1,2-dimethyl-1,2-et henediyl)bis-, (E)-	63120	000782-06-9	62
49	53.076	1.84	C:\Database\NIST05a.L			
			Benzene, 1,1'-(1-butene-1,4-diyl)b is-, (Z)-	63107	070388-65-7	87
			Indan, 1-methyl-	13588	000767-58-8	72
			Benzene, (1-ethyl-2-propenyl)-	20800	019947-22-9	72
50	53.514	1.29	C:\Database\NIST05a.L			
			1,3-Propanediol, 2-methyl-2-phenyl	33222	024765-53-5	64
			.alpha.-Methyl-.alpha.-phenylsucci nimide	49259	001497-17-2	64
			Hex-1-ene,2,5-diphenyl-	82663	032375-29-4	59
51	55.202	0.38	C:\Database\NIST05a.L			
			(1-Benzyl-1H-indol-3-yl)-acetaldeh yde	91377	1000188-47-3	14
			Benzene, 1,1'-(1-ethyl-1,3-propane diyl)bis-	74551	000838-45-9	11
			.beta.-Alanine, N-(3-ethoxy-3-oxop ropyl)-N-(phenylmethyl)-, ethyl es ter	129019	006938-07-4	9
52	56.580	0.77	C:\Database\NIST05a.L			
			2,5-Diphenyl-1,5-hexadiene	81258	007283-49-0	99
			Bicyclo[2.1.1]hexane, 1,4-diphenyl	81266	118476-61-2	92
			2,3-Diazabicyclo[2.2.2]oct-2-ene, 1,4-diphenyl-	100180	087433-33-8	90
53	56.975	0.05	C:\Database\NIST05a.L			
			Butylated Hydroxytoluene	71370	000128-37-0	47
			Benzene, 1,1'-(1-methyl-2-butynyli	71522	054372-84-8	47

?k#	RT	Area%	Library/ID	Ref#	CAS#	Qual
			dene)bis-			
			Phenol, 4,6-di(1,1-dimethylethyl)-2-methyl-	71398	000616-55-7	46
54	57.755	0.91	C:\Database\NIST05a.L			
			2-Methylbenzyl cyanide	13561	022364-68-7	25
			((N-(2-Cyanoethyl)-N-methylamino)-(3-indolyl)methylene)malononitrile	108769	1000240-68-7	22
			3(2H)-Furanone, dihydro-2,2-dimethyl-5-phenyl-	49861	063678-00-2	20
55	59.496	2.06	C:\Database\NIST05a.L			
			2,3-Diazabicyclo[2.2.1]hept-2-ene, 1,4-diphenyl-	90805	106230-80-2	94
			1,5-Diphenylpyrazole	71291	006831-89-6	52
			Tricyclo[9.2.2.2(4,7)]heptadeca-1(14),2,4(17),5,7(16),11(15),12-heptaene	71525	049576-90-1	50
56	60.489	1.73	C:\Database\NIST05a.L			
			1-(4-Methylphenyl)-4-phenylbuta-1,3-diene	71521	037985-11-8	55
			2,3-Diazabicyclo[2.2.1]hept-2-ene, 1,4-diphenyl-	90805	106230-80-2	45
			Furane, 2,5-diphenyl-	71478	026569-47-1	35
57	61.152	0.57	C:\Database\NIST05a.L			
			2-Buten-1-one, 1,3-diphenyl-	73037	000495-45-4	96
			1-Phenoxyphthalazine	72688	100537-30-2	46
			2-Buten-1-one, 1,3-diphenyl-	73039	000495-45-4	46
58	61.985	2.73	C:\Database\NIST05a.L			
			1,5-Diphenyl-1,5-hexadiene	81257	1000211-27-2	93
			Benzene, [(3-phenyl-2-propenyl)thio]-	76002	010276-14-9	47
			Benzene, 1,1'-(1,5-hexadiene-1,6-diyl)bis-	81279	004439-45-6	43
59	65.083	0.66	C:\Database\NIST05a.L			
			1H-Cyclopenta[l]phenanthrene, 2,3-dihydro-	70036	000723-98-8	83
			Naphthalene, 2-(phenylmethyl)-	70035	000613-59-2	83
			Naphthalene, 2-(phenylmethyl)-	70034	000613-59-2	58
60	66.525	2.13	C:\Database\NIST05a.L			
			Naphthalene, 2-(phenylmethyl)-	70035	000613-59-2	55
			1H-Cyclopenta[l]phenanthrene, 2,3-dihydro-	70036	000723-98-8	55
			8-Amino-2,6-dimethoxylepidine	69652	074509-65-2	43
61	67.742	3.22	C:\Database\NIST05a.L			
			Heptadecane	85524	000629-78-7	97
			Tetratetracontane	188836	007098-22-8	91
			Tetratriacontane	182859	014167-59-0	91

Mixture

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Operator   : FIZA
Acquired   : 29 Sep 2016  10:24     using AcqMethod LIQUID FUEL.M
Instrument :
    GCMSD
Sample Name: Z
Misc Info  :
Vial Number: 2
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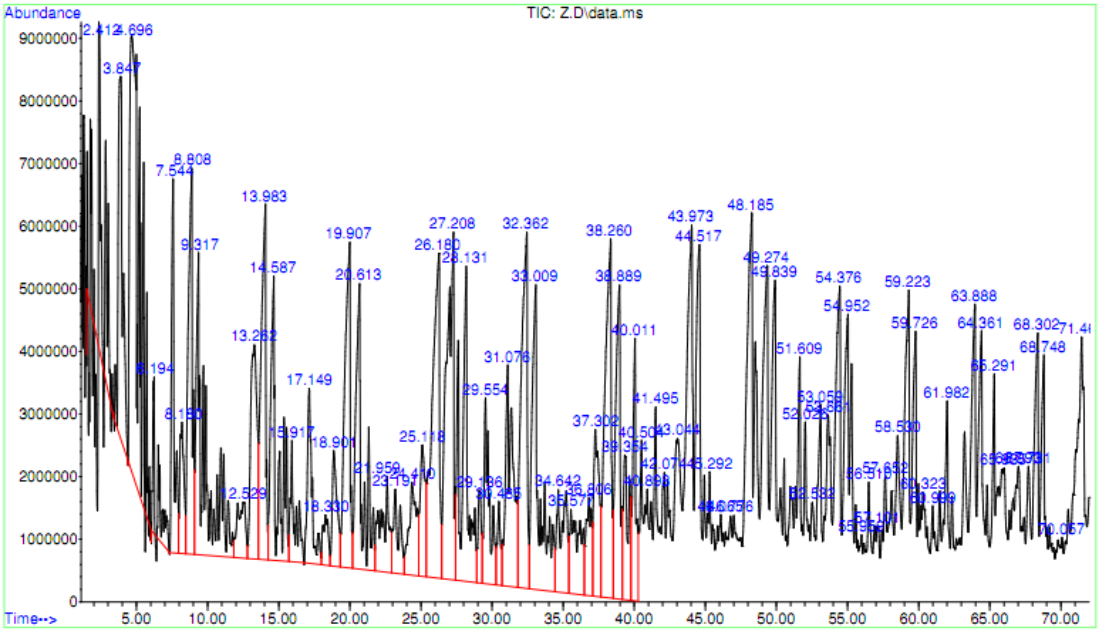

Pk#	RT	Area%	Library/ID	Ref#	CAS#	Qual
1	2.412	0.97	C:\Database\NIST05a.L			
			Toluene	2395	000108-88-3	94
			Toluene	2400	000108-88-3	94
			Toluene	2398	000108-88-3	90
2	3.843	1.60	C:\Database\NIST05a.L			
			2,4-Dimethyl-1-heptene	11187	019549-87-2	96
			2,4-Dimethyl-1-heptene	11183	019549-87-2	90
			1-Heptene, 5-methyl-	6498	013151-04-7	59
3	4.698	4.01	C:\Database\NIST05a.L			
			1,3,5,7-Cyclooctatetraene	4757	000629-20-9	97
			Styrene	4752	000100-42-5	96
			Bicyclo[4.2.0]octa-1,3,5-triene	4759	000694-87-1	96
4	6.193	0.51	C:\Database\NIST05a.L			
			Benzaldehyde	4937	000100-52-7	96
			Benzaldehyde	4936	000100-52-7	93
			Benzaldehyde	4934	000100-52-7	91
5	7.539	0.99	C:\Database\NIST05a.L			
			.alpha.-Methylstyrene	8689	000098-83-9	96
			.alpha.-Methylstyrene	8693	000098-83-9	93
			.alpha.-Methylstyrene	8692	000098-83-9	89
6	8.180	0.52	C:\Database\NIST05a.L			
			Cyclodecene	16281	003618-12-0	70
			1,11-Dodecadiene	33507	005876-87-9	52
			Cyclooctene, 3-methyl-	10314	013152-05-1	49
7	8.810	1.54	C:\Database\NIST05a.L			
			1-Decene	17321	000872-05-9	98
			1-Decene	17320	000872-05-9	97
			1-Decene	17319	000872-05-9	94
8	9.312	2.31	C:\Database\NIST05a.L			
			Decane	18488	000124-18-5	97
			Decane	18485	000124-18-5	95
			Decane	18487	000124-18-5	95
9	12.527	0.43	C:\Database\NIST05a.L			
			Bicyclo[3.1.1]heptane, 2,6,6-trimethyl-	16407	000473-55-2	70
			1,7-Nonadiene, 4,8-dimethyl-	24404	062108-28-5	64
			Bicyclo[2.2.2]octane, 2-methyl-	10368	000766-53-0	55
10	13.265	1.29	C:\Database\NIST05a.L			
			Cyclopentane, propyl-	6514	002040-96-2	52
			Cyclopentane, propyl-	6511	002040-96-2	52
			3-Heptene, 2-methyl-, (E)-	6560	000692-96-6	38
11	13.980	1.64	C:\Database\NIST05a.L			
			1-Undecene	25902	000821-95-4	95
			1-Undecene	25904	000821-95-4	93
			3-Undecene, (Z)-	25915	000821-97-6	93
12	14.589	1.58	C:\Database\NIST05a.L			
			Undecane	27239	001120-21-4	95
			Undecane	27236	001120-21-4	94

?k#	RT	Area%	Library/ID	Ref#	CAS#	Qual
			Tetradecane	55974	000629-59-4	90
13	15.914	0.52	C:\Database\NIST05a.L			
			Ethanone, 1-cyclohexyl-	10999	000823-76-7	46
			Cyclohexanone, 2,3-dimethyl-	11061	013395-76-1	38
			Furan, 2,3-dihydro-3-methyl-	1418	001708-27-6	22
14	17.153	0.78	C:\Database\NIST05a.L			
			2-Isopropenyl-5-methylhex-4-enal	24118	075697-98-2	47
			Cyclopropanemethanol, 2-methyl-2-(4-methyl-3-pentenyl)-	34921	098678-70-7	40
			6,11-Dimethyl-2,6,10-dodecatrien-1 -ol	62953	1000196-53-3	38
15	18.328	0.25	C:\Database\NIST05a.L			
			2,7-Octadiene, 4-methyl-	10320	1000061-78-0	64
			3,4-Octadiene, 7-methyl-	10330	037050-05-8	60
			Cycloundecene, 1-methyl-	33534	088828-82-4	58
16	18.905	0.53	C:\Database\NIST05a.L			
			9-Eicosyne	110846	071899-38-2	91
			1,11-Dodecadiene	33507	005876-87-9	90
			E,Z-2,13-Octadecadien-1-ol	102828	1000131-10-0	86
17	19.909	1.67	C:\Database\NIST05a.L			
			1-Dodecene	34945	000112-41-4	96
			1-Dodecene	34944	000112-41-4	94
			1-Undecanol	37772	000112-42-5	91
18	20.614	1.66	C:\Database\NIST05a.L			
			Dodecane	36431	000112-40-3	96
			Dodecane	36429	000112-40-3	95
			Dodecane	36430	000112-40-3	94
19	21.960	0.69	C:\Database\NIST05a.L			
			Benzene, cyclohexyl-	29529	000827-52-1	46
			Benzene, (3-methylcyclopentyl)-	29537	005078-75-1	42
			Benzene, cyclohexyl-	29527	000827-52-1	38
20	23.188	0.47	C:\Database\NIST05a.L			
			Benzene, (3-methylcyclopentyl)-	29537	005078-75-1	44
			Nonane, 4,5-dimethyl-	27253	017302-23-7	35
			Naphthalene, 2-ethyl-1,2,3,4-tetra hydro-	29569	032367-54-7	35
21	24.406	0.67	C:\Database\NIST05a.L			
			4-Isopropylcyclohexanone	18049	005432-85-9	43
			Pentane, 3-methylene-	1466	000760-21-4	38
			Pentane, 3-methylene-	1469	000760-21-4	30
22	25.122	0.63	C:\Database\NIST05a.L			
			13-Oxabicyclo[10.1.0]tridecane	44556	000286-99-7	74
			1-Octadecyne	92239	000629-89-0	72
			1-Pentadecyne	63039	000765-13-9	64
23	26.179	2.30	C:\Database\NIST05a.L			
			1-Tridecene	44618	002437-56-1	98
			1-Tridecene	44614	002437-56-1	97
			1-Tridecene	44617	002437-56-1	97

Pk#	RT	Area%	Library/ID	Ref#	CAS#	Qual
24	27.204	2.33	C:\Database\NIST05a.L			
			Cyclohexane, 1,2,4-trimethyl-	11237	002234-75-5	45
			2-Undecene, 4-methyl-	34999	091695-32-8	43
			Cyclohexane, 1,3,5-trimethyl-, (1. alpha.,3.alpha.,5.beta.)-	11279	001795-26-2	35
25	28.134	1.87	C:\Database\NIST05a.L			
			4-Isopropyl-1,3-cyclohexanedione	26500	062831-62-3	53
			Cyclohexane, 1,1-dimethyl-2-propyl	25982	081983-71-3	49
			Hexane, 2,3,4-trimethyl-	12319	000921-47-1	38
26	29.138	0.30	C:\Database\NIST05a.L			
			Trichloroacetic acid, undec-10-eny l ester	132995	1000280-51-3	52
			7-Tetradecyne	52910	035216-11-6	49
			1,13-Tetradecadiene	52921	021964-49-8	49
27	29.555	0.95	C:\Database\NIST05a.L			
			Benzene, (3-methyl-1-methylenepent yl)-	39051	074810-69-8	64
			4-(para-Tolyl)-butyric acid	41409	004521-22-6	64
			Benzenepropanoic acid, 3-phenylpro pyl ester	104184	060045-27-4	64
28	30.484	0.26	C:\Database\NIST05a.L			
			5-Phenethyl-2H-pyrazol-3-ol	48488	1000311-62-9	35
			Cyclopropylphenylmethane	13603	001667-00-1	27
			Benzenepropanenitrile	13543	000645-59-0	25
29	31.071	1.52	C:\Database\NIST05a.L			
			Triallylsilane	25058	001116-62-7	35
			6-Dodecene, (E)-	34957	007206-17-9	35
			Decane, 3-cyclohexyl-	74533	013151-74-1	30
30	32.364	2.02	C:\Database\NIST05a.L			
			2-Tetradecene, (E)-	54521	035953-53-8	99
			1-Tetradecene	54512	001120-36-1	96
			1-Tetradecene	54508	001120-36-1	95
31	33.005	2.09	C:\Database\NIST05a.L			
			Tetradecane	55975	000629-59-4	98
			Tetradecane	55972	000629-59-4	97
			Tetradecane	55974	000629-59-4	95
32	34.639	0.81	C:\Database\NIST05a.L			
			17-Pentatriacontene	183897	006971-40-0	35
			2,5-Cyclohexadiene-1,4-dione, 3-hy droxy-2-methyl-5-(1-methylethyl)-	42794	004586-58-7	35
			Cyclopropanemethanol, 2-methyl-2-(4-methyl-3-pentenyl)-	34921	098678-70-7	25
33	35.579	0.81	C:\Database\NIST05a.L			
			cis-11-Hexadecenal	83994	053939-28-9	53
			1-Cyclopentyl-4-(1-methylethyl)cyc lohexane	52948	1000215-44-4	46
			1-Pentadecyne	63039	000765-13-9	42
34	36.808	0.52	C:\Database\NIST05a.L			

Pk#	RT	Area%	Library/ID	Ref#	CAS#	Qual
			Benzene, 1,1'-(1,2-ethanediyl)bis-	44685	000103-29-7	55
			Benzene, 1,1'-(1,2-ethanediyl)bis-	44684	000103-29-7	55
			Benzene, 1,1'-(1,2-ethanediyl)bis-	44683	000103-29-7	49
35	37.299	0.85	C:\Database\NIST05a.L			
			1-Pentadecyne	63039	000765-13-9	95
			cis-11-Tetradecen-1-ol	65996	034010-15-6	93
			1,12-Tridecadiene	43179	021964-48-7	91
36	38.260	2.17	C:\Database\NIST05a.L			
			1-Pentadecene	64457	013360-61-7	98
			1-Pentadecene	64456	013360-61-7	91
			9-Octadecene, (E)-	93547	007206-25-9	91
37	38.891	1.41	C:\Database\NIST05a.L			
			Pentadecane	66066	000629-62-9	98
			Pentadecane	66067	000629-62-9	96
			Pentadecane	66063	000629-62-9	93
38	39.350	0.73	C:\Database\NIST05a.L			
			1-Undecene, 8-methyl-	34980	074630-40-3	76
			Dichloroacetic acid, heptadecyl es ter	159590	1000282-98-2	60
			1-Heptadecene	84041	006765-39-5	53
39	40.012	0.80	C:\Database\NIST05a.L			
			Cyclohexane, 1,2,4-trimethyl-	11233	002234-75-5	55
			Bacchotricuneatin c	148777	066563-30-2	50
			Pentafluoropropionic acid, heptade cyl ester	171753	1000283-04-2	43
40	40.504	0.48	C:\Database\NIST05a.L			
			Cyclohexane, 1,2,4-trimethyl-	11233	002234-75-5	55
			Cyclohexane, 1,2,4-trimethyl-	11235	002234-75-5	55
			2,2-Dimethyl-3-heptene trans	11219	019550-75-5	38
41	40.899	0.61	C:\Database\NIST05a.L			
			Heptafluorobutyric acid, n-pentade cyl ester	176048	1000216-79-3	80
			Cyclopentane, 1-butyl-2-propyl-	35063	062199-50-2	53
			Cyclooctane, methyl-	11177	001502-38-1	52
42	41.497	0.69	C:\Database\NIST05a.L			
			6-Tridecene, 7-methyl-	54546	024949-42-6	58
			Cyclohexane, 1,2,4-trimethyl-	11237	002234-75-5	46
			Cyclohexane, 1,1,2-trimethyl-	11223	007094-26-0	43
43	42.074	0.92	C:\Database\NIST05a.L			
			Oxirane, 2-decyl-3-(5-methylhexyl) -, cis-(.+/-.)-	113475	057457-72-4	50
			Bicyclo[3.1.1]heptan-3-one, 2,6,6- trimethyl-, (1.alpha.,2.beta.,5.al pha.)-	24332	015358-88-0	50
			1-Tridecyn-4-ol	54425	074646-37-0	47
44	43.046	1.03	C:\Database\NIST05a.L			
			1,19-Eicosadiene	110851	014811-95-1	83
			1,19-Eicosadiene	110850	014811-95-1	81
			11-Hexadecen-1-ol, (Z)-	85510	056683-54-6	80

Pk#	RT	Area%	Library/ID	Ref#	CAS#	Qual
45	43.975	2.26	C:\Database\NIST05a.L			
			1-Hexadecene	74520	000629-73-2	97
			Z-8-Hexadecene	74523	1000130-87-5	96
			1-Hexadecene	74522	000629-73-2	96
46	44.520	1.86	C:\Database\NIST05a.L			
			Hexadecane	76091	000544-76-3	98
			Hexadecane	76093	000544-76-3	97
			Hexadecane	76092	000544-76-3	96
47	45.289	0.64	C:\Database\NIST05a.L			
			Cyclohexane, 1,1'-(1-methylethylidene)bis-	63053	054934-90-6	43
			1,1'-Bicyclohexyl, 2-ethyl-, cis-	52936	050991-12-3	43
			Cyclohexane, 1,2-diethyl-1-methyl-	25976	061141-79-5	38
48	46.069	0.74	C:\Database\NIST05a.L			
			Benzene, 1,1'-(3-methyl-1-propene-1,3-diyl)bis-	63118	007614-93-9	55
			Benzene, 1,1'-(1,2-dimethyl-1,2-ethenediyl)bis-, (Z)-	63119	000782-05-8	52
			Benzene, 1,1'-(1,2-dimethyl-1,2-ethenediyl)bis-, (E)-	63120	000782-06-9	51
49	46.774	0.93	C:\Database\NIST05a.L			
			7-Hexadecenal, (Z)-	83997	056797-40-1	58
			Thieno[2,3-d]-1,3-thiaselenol-2-thione	84091	081803-09-0	56
			1-Dodecanol, 3,7,11-trimethyl-	77417	006750-34-1	49
50	48.184	3.23	C:\Database\NIST05a.L			
			N-Benzyl-1H-benzimidazole	62907	004981-92-4	27
			Benzene, 3-butynyl-	12680	016520-62-0	22
			Benzene, (3-nitropropyl)-	32997	022818-69-5	16
51	49.273	1.88	C:\Database\NIST05a.L			
			3-Heptadecene, (Z)-	84042	1000141-67-3	99
			E-14-Hexadecenal	83987	330207-53-9	99
			1-Heptadecene	84041	006765-39-5	99
52	49.840	2.22	C:\Database\NIST05a.L			
			Heptadecane	85524	000629-78-7	97
			Heptadecane	85525	000629-78-7	96
			Heptadecane	85523	000629-78-7	96
53	51.613	1.68	C:\Database\NIST05a.L			
			Cyclohexane, 1,2,4-trimethyl-	11235	002234-75-5	43
			Hexadecane	76092	000544-76-3	35
			Cyclohexane, 1,1,3,5-tetramethyl-, cis-	17447	050876-32-9	30
54	52.029	0.69	C:\Database\NIST05a.L			
			Cyclopentane, (2-methylbutyl)-	17408	053366-38-4	42
			Cyclohexane, 1-ethyl-2-propyl-	25967	062238-33-9	38
			Bicyclo[3.1.1]heptan-3-one, 6,6-dimethyl-2-(2-methylpropyl)-	52871	1000163-97-9	38
55	52.531	0.39	C:\Database\NIST05a.L			

Pk#	RT	Area%	Library/ID	Ref#	CAS#	Qual
			2-Methyl-Z-4-tetradecene	64465	1000130-78-3	64
			1-Decanol, 2-hexyl-	86865	002425-77-6	60
			Cyclopentane, 1-pentyl-2-propyl-	44642	062199-51-3	60
56	53.055	0.87	C:\Database\NIST05a.L			
			3-Trifluoroacetoxy-6-ethyldecane	113014	116436-59-0	43
			Cyclohexane, 1,2,4-trimethyl-	11235	002234-75-5	43
			Decane, 1,1'-oxybis-	123793	002456-28-2	30
57	53.664	1.12	C:\Database\NIST05a.L			
			1,19-Eicosadiene	110851	014811-95-1	74
			Z,Z-2,15-Octadecedien-1-ol acetate	129818	1000130-95-1	70
			1,19-Eicosadiene	110850	014811-95-1	64
58	54.379	1.72	C:\Database\NIST05a.L			
			E-15-Heptadecenal	93518	1000130-97-9	99
			1-Octadecene	93544	000112-88-9	98
			1-Nonadecene	102860	018435-45-5	95
59	54.956	2.35	C:\Database\NIST05a.L			
			Octadecane	94930	000593-45-3	97
			Octadecane	94931	000593-45-3	96
			10-Methylnonadecane	113493	056862-62-5	91
60	55.960	0.45	C:\Database\NIST05a.L			
			2-Tetradecene, (E)-	54521	035953-53-8	70
			9-Octadecene, (E)-	93547	007206-25-9	62
			5-Octadecene, (E)-	93546	007206-21-5	62
61	56.505	0.55	C:\Database\NIST05a.L			
			2,4-Dimethylhexanedioic acid, 6-methyl ester	49078	1000187-74-2	35
			2,2-Dimethyl-3-heptene trans	11219	019550-75-5	35
			1-Cyclohexyl-1-(4-ethylcyclohexyl) ethane	73077	002027-13-6	35
62	57.103	0.60	C:\Database\NIST05a.L			
			Cyclohexane, 1,1'-propylidenebis-	63046	054934-91-7	58
			Decane, 4-cyclohexyl-	74535	013151-75-2	55
			Cyclopentane, (2-methylpropyl)-	11250	003788-32-7	53
63	57.648	1.25	C:\Database\NIST05a.L			
			Cyclopropanecarboxylic acid, 2-phenylethyl ester	49868	1000245-59-4	27
			6-Methyl-3-nitro-6,7-dihydro-9H-5-oxa-9-azabenzocyclohepten-8-one	72205	134076-63-4	20
			Phenyl ethyl tiglate	59614	055719-85-2	18
64	58.535	0.88	C:\Database\NIST05a.L			
			1,19-Eicosadiene	110851	014811-95-1	96
			1,19-Eicosadiene	110850	014811-95-1	91
			Z,E-2,13-Octadecadien-1-ol	102829	1000131-10-3	86
65	59.218	1.68	C:\Database\NIST05a.L			
			Z-5-Nonadecene	102861	1000131-11-8	99
			1-Nonadecene	102860	018435-45-5	95
			E-14-Hexadecenal	83987	330207-53-9	95
66	59.731	1.39	C:\Database\NIST05a.L			

Pk#	RT	Area%	Library/ID	Ref#	CAS#	Qual
			Nonadecane	104272	000629-92-5	96
			Nonadecane	104271	000629-92-5	96
			Heptadecane	85525	000629-78-7	91
67	60.319	0.87	C:\Database\NIST05a.L			
			Isoquinoline, 1,2,3,4-tetrahydro-1-allyl-6,7-dimethoxy-3,3-dimethyl-	99382	180461-39-6	25
			1H-Pyrazole, 3,5-diphenyl-	71299	001145-01-3	25
			Naphthalene, 1-phenoxy-	71481	003402-76-4	25
68	61.002	0.58	C:\Database\NIST05a.L			
			Triallylsilane	25058	001116-62-7	53
			Zinc, bis[2-(1,1-dimethylethyl)-3,3-dimethylcyclopropyl]-, [1.alpha.(1R*,2R*),2.beta.]-	133356	074793-36-5	47
			Bicyclo[2.2.1]heptane-2,5-dione, 1,7,7-trimethyl-	33284	004230-32-4	43
69	61.985	3.18	C:\Database\NIST05a.L			
			Cyclohexane, 1,1,2-trimethyl-	11223	007094-26-0	38
			Cyclohexane, 1,1,3,5-tetramethyl-, cis-	17447	050876-32-9	30
			Cyclooctane, ethyl-	17357	013152-02-8	30
70	63.886	1.54	C:\Database\NIST05a.L			
			Cycloeicosane	112104	000296-56-0	95
			E-15-Heptadecenal	93518	1000130-97-9	95
			1-Nonadecene	102860	018435-45-5	94
71	64.356	1.79	C:\Database\NIST05a.L			
			Eicosane	113492	000112-95-8	99
			Heptadecane	85523	000629-78-7	94
			Eicosane	113490	000112-95-8	94
72	65.296	1.24	C:\Database\NIST05a.L			
			1-Cyclopentyl-4-(1-methylethyl)cyclohexane	52948	1000215-44-4	53
			Cyclooctane, 1-methyl-3-propyl-	35064	255885-37-1	47
			Cyclohexane, 2,4-diethyl-1-methyl-	25975	061142-70-9	47
73	65.937	1.03	C:\Database\NIST05a.L			
			E-15-Heptadecenal	93518	1000130-97-9	97
			9-Tricosene, (Z)-	138119	027519-02-4	96
			9-Tricosene, (Z)-	138118	027519-02-4	96
74	66.995	2.05	C:\Database\NIST05a.L			
			Heptadecane	85523	000629-78-7	92
			Heptadecane	85525	000629-78-7	91
			Hexadecane, 2,6,10,14-tetramethyl-	113507	000638-36-8	90
75	67.732	0.65	C:\Database\NIST05a.L			
			1,19-Eicosadiene	110851	014811-95-1	91
			(Z)-14-Tricosenyl formate	159805	077899-10-6	90
			Bicyclo[10.8.0]eicosane, cis-	110854	1000155-82-2	64
76	68.298	1.37	C:\Database\NIST05a.L			
			Z-5-Nonadecene	102861	1000131-11-8	99
			1-Nonadecene	102860	018435-45-5	97
			10-Heneicosene (c,t)	121168	095008-11-0	95

Pk#	RT	Area%	Library/ID	Ref#	CAS#	Qual
77	68.747	1.81	C:\Database\NIST05a.L			
			Heneicosane	122435	000629-94-7	98
			Heneicosane	122436	000629-94-7	96
			Heptadecane	85523	000629-78-7	95
78	70.061	0.74	C:\Database\NIST05a.L			
			1-Nonadecene	102860	018435-45-5	83
			Isotridecanol-	57271	027458-92-0	68
			3-Heptadecene, (Z)-	84042	1000141-67-3	58
79	71.471	3.07	C:\Database\NIST05a.L			
			Benzonitrile, m-phenethyl-	62228	034176-91-5	25
			2-Propenoic acid, 3-[(phenylmethyl)thio]-, (E)-	52240	013831-01-1	22
			Benzene, (5-iodopentyl)-	107726	099858-37-4	12