



CHAPTER I

INTRODUCTION

1.1 Local Plastic Industry

Today, the plastic industry in Thailand have been growing at a high rate. There is a huge demand on plastic material both in commodity and engineering plastics. Plastic is very popular because it can replace metals and wood in a variety of applications. It can be easily molded. It has light weight so it can be easily transported.

Only two decades ago, several small plastic processing plants producing finished products for household use in the domestic market were established. These plants use imported plastic resins. Soon after, plants producing polyvinyl chloride (PVC), polystyrene (PS) and polyester were built. The intermediate monomers were imported. All these downstream polymer and plastic processing plants were principally situated in the Bangkok area near major markets. The total number of plastic processing plants today is approximately 2,000

Early plastics were manufactured from coal and natural products such as milk, cellulose, and molasses but today plastics are made almost exclusively from petroleum. Thailand's Petrochemical Industry has a rapid growth, from processing consumer products to the production of basic raw material. Over the past three years from 1988 to 1990, Thailand set a world record in economic growth averaging 11.7% .

The discovery of abundant supplies of natural gas in the gulf of Thailand during the mid-70s served as a catalyst for the most ambitious large - scale multi- billion dollar project ever undertaken in Thailand. The gas is processed and separated in the Gas Separation Plant into fuel gas (mainly methane), ethane and propane, LPG and natural gasoline. Ethane and Propane are feedstocks for the petrochemical complex for the final production of various kinds of plastics, ie

- High Density Polyethylene (HDPE)
- Low Density Polyethylene (LDPE)
- Polypropylene (PP)
- Poly vinyl chloride (PVC)

The petrochemical complex of the upstream unit and central facilities plant are run by National Petrochemical Corporation Ltd. (NPC) and four downstreamers : Thai Polyethylene Co., Ltd. (TPE), Thai Petrochemical Industry Co., Ltd. (TPI), HMC Polymers Co., Ltd. (HMC), and Thai Plastic & Chemical Co., Ltd. (TPC)

The complex structure is shown in Figure 1.7. The capacities of olefins and polyolefins unit were shown in Table 1.1 . As seen from the market demands in Figure 1.1 to 1.6. (1), the first olefins - polyolefins complex cannot fulfill these demands. Furthermore, Thailand has been importing other petrochemicals such as aromatic derivatives. Consequently, the second phase of the development, popularly known as NPC2 , was conceived in 1988. The olefins, the aromatics and their derivatives with their respective capacities are shown in Figure 1.8. The capacities of these plants are shown in Table 1.2 Market demands of polystyrene and ABS are shown in Table 1.3 and 1.4 (2). The quantities of imported resins and exported resins in 1991-1992 are shown in Table 1.5 and 1.6. (3, 4).

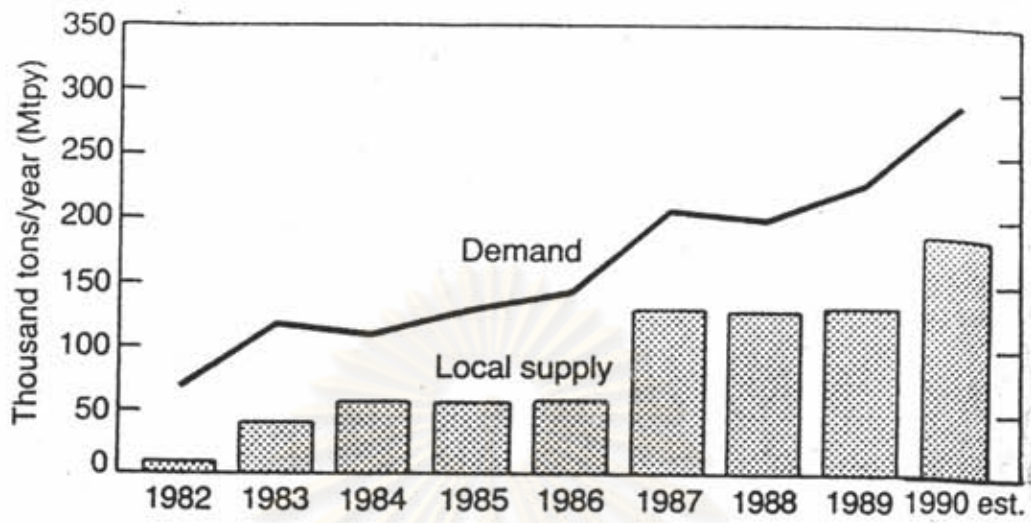


Figure 1.1 Thailand polyethylene demand VS. local supply
(1982-1990)

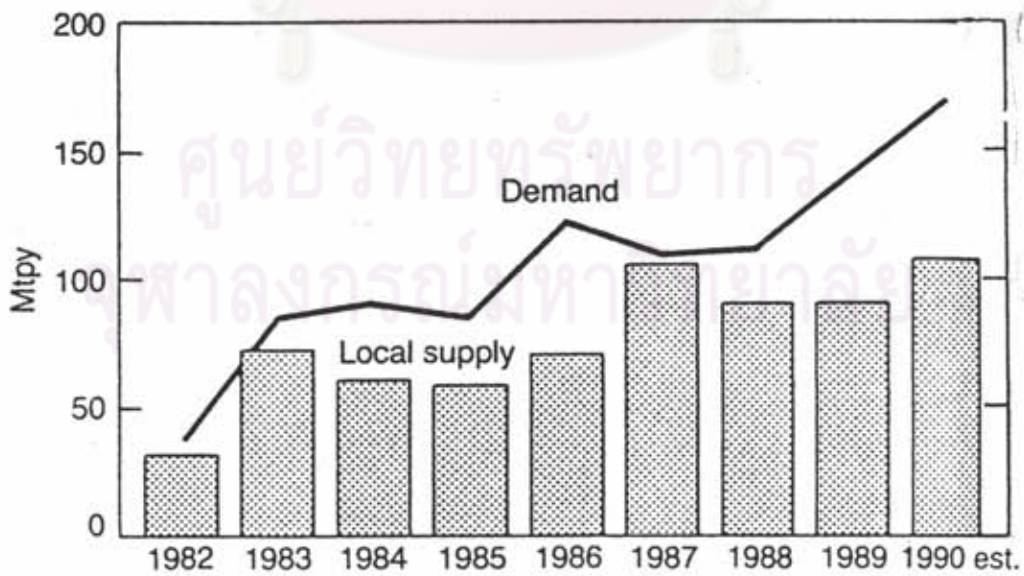


Figure 1.2 Thailand PVC demand VS. local supply (1982-1990)

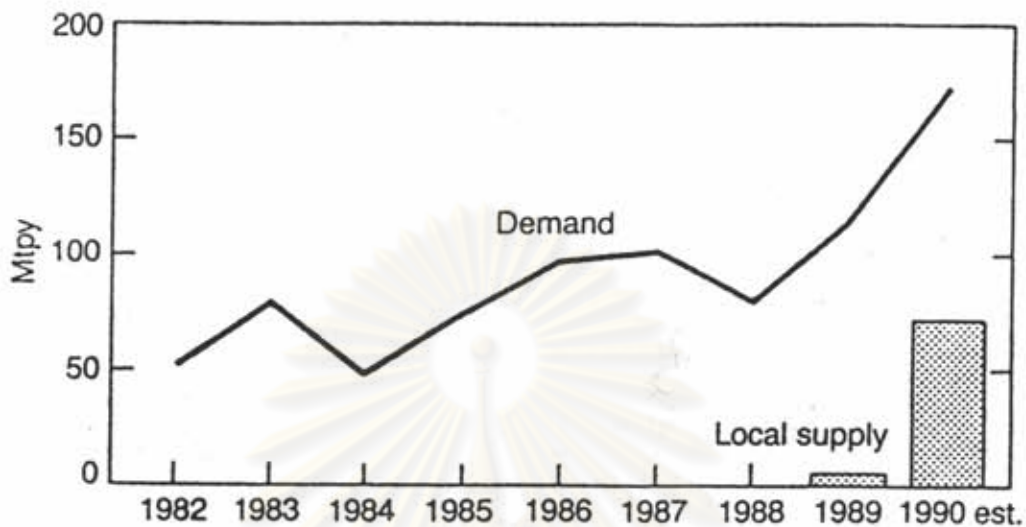


Figure 1.3 Thailand polypropylene demand VS. local supply (1982-1990)

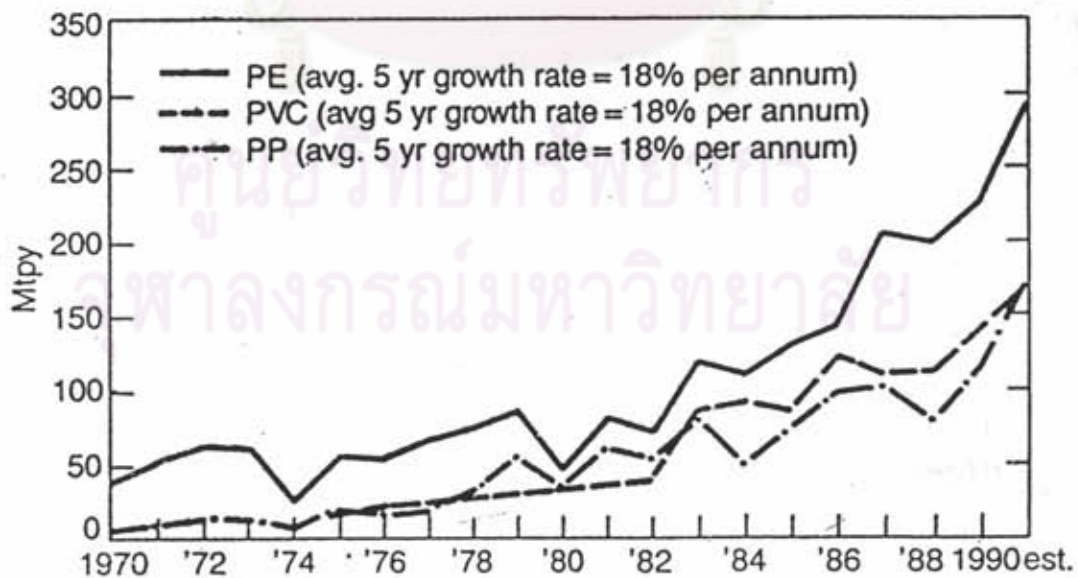


Figure 1.4 Thailand polyolefins demand growth (1970-1990)

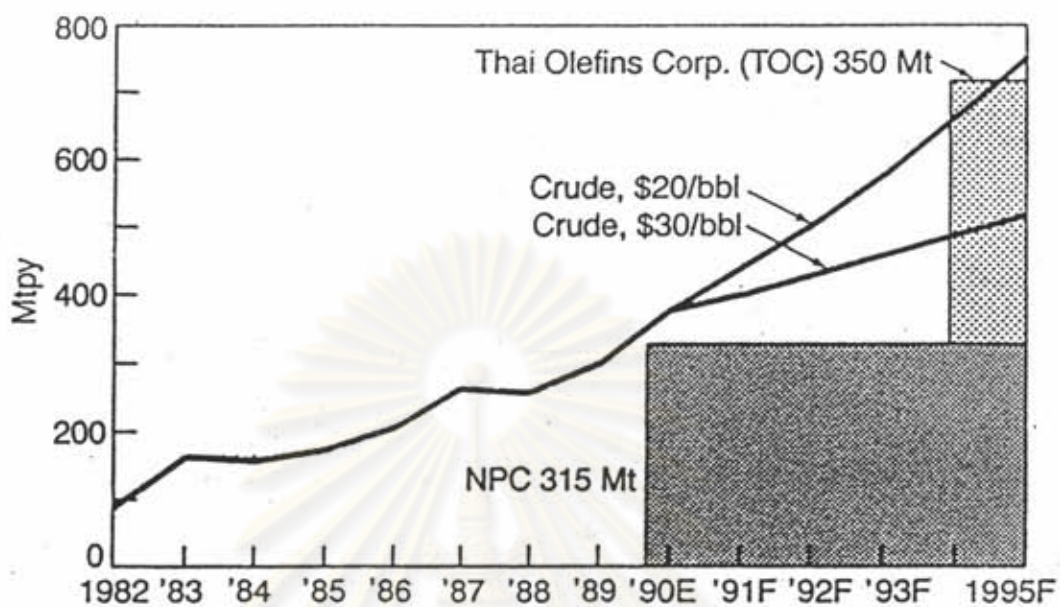


Figure 1.5 Thailand ethylene demand VS. supply capacity

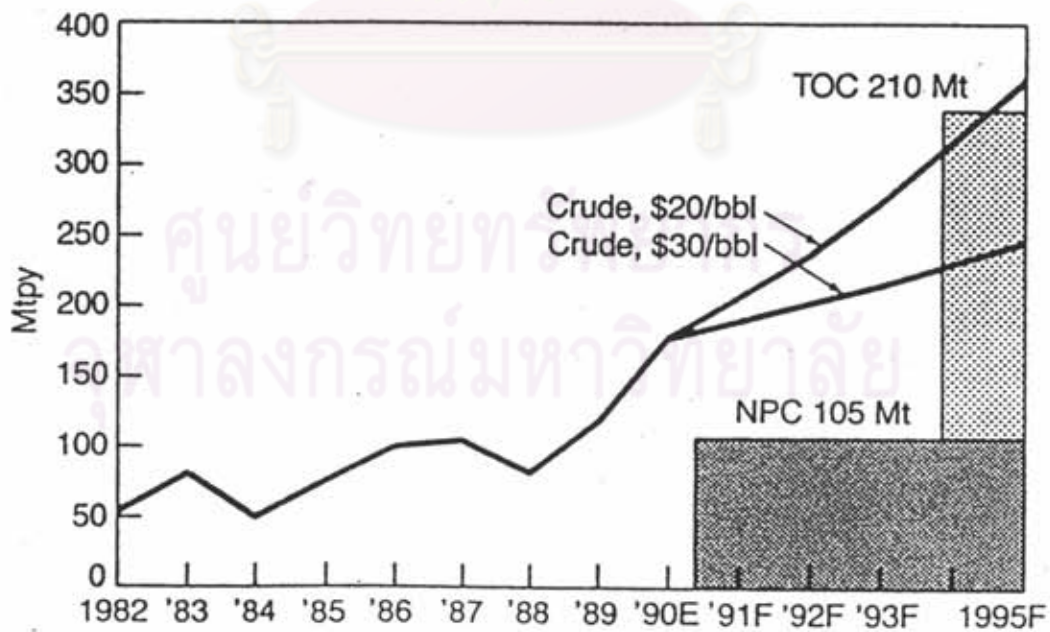


Figure 1.6 Thailand propylene demand VS. supply capacity

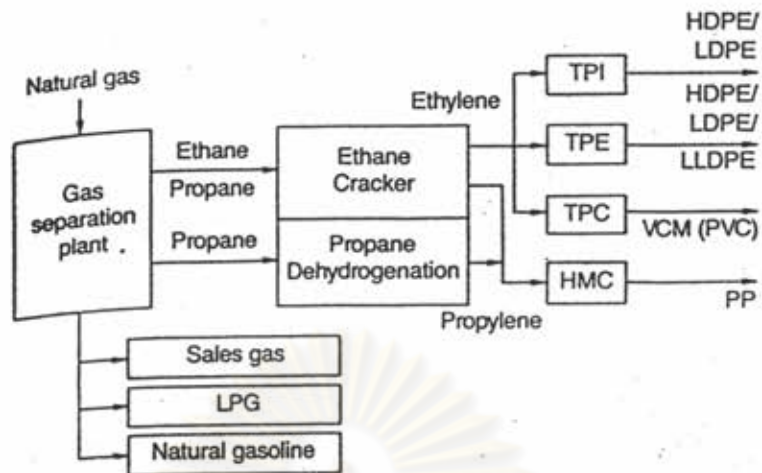


Figure 1.7 NPC petrochemical complex

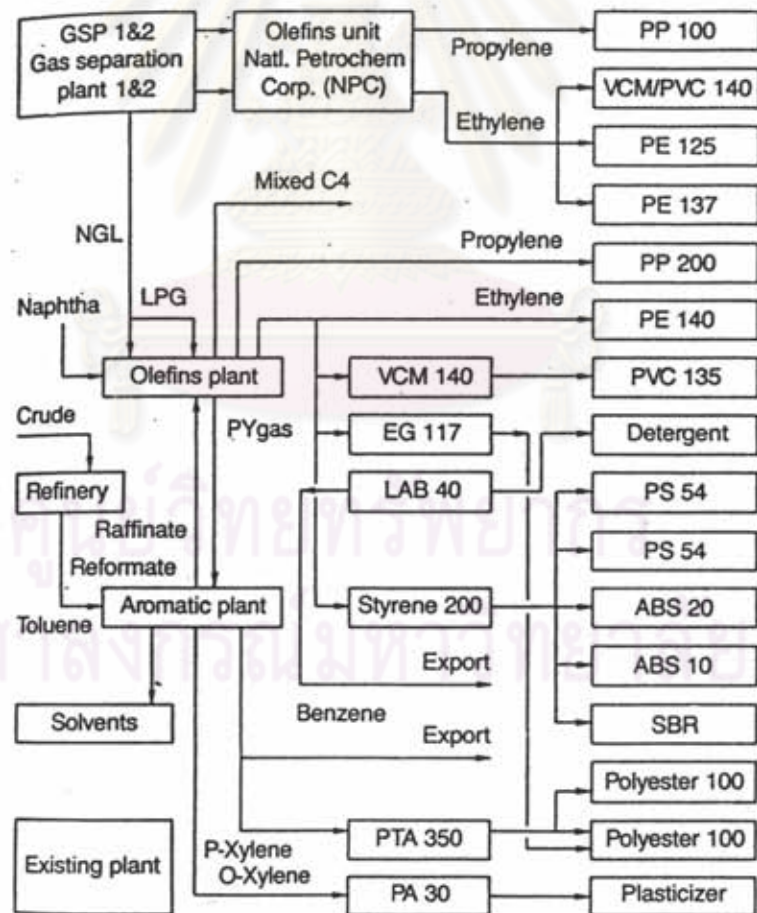


Figure 1.8 NPC2 petrochemical complex

Table 1.1 NPC 1 complex capacities

NPC 1 complex group	Units	Product capacities (T/Y)
National Petrochemical Corp.,Ltd. (NPC)	Ethylene	315,000
	Propylene	105,000
Thai Petrochemical Industry	LDPE	65,000
Co.,Ltd.(TPI)	HDPE/LLDPE	60,000
Thai Polyethylene Co.,	PE	137,500
Ltd.(TPE)		
Thai Plastic and Chemical	VCM/PVC	140,000
Co.,Ltd.(TPC)		
HMC Polymers Co.,	PP	100,000
Ltd.(HMC)		

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Table 1.2 The second petrochemical complex (NPC) and capacity

NPC 2 complex group	Units	Product capacities (T/Y)
Thai Olefins Co.,Ltd.(TOC)	Ethylene	350,000
	Propylene	210,000
	MixedCAs	100,000
Aromatics (Thailand) Co., Ltd.(TAC)	Benzene	116,000
	Paraxylene	168,000
	Orthoxylene	29,000
Bangkok Polyethylene Co., Ltd.(BPE)	PE	140,000
Thai Petrochemical Industry Co., Ltd. (TPI)	PP	100,000
Thai Polypropylene Co., Ltd. (TPP)	PP	100,000
Vinylthai Co., Ltd.	VCM/PVC	140,000
BBL Group	Butadiene,MTBE	
	MEK,polybutadiene	
Siam Cement Co., and Sumitomo Chemical	MMA	40,000
Siam Styrene Monomer Co.,Ltd.	SM	200,000

Table 1.2 Continued

NPC 2 complex group	Units	Product capacities (T/Y)
Thai Petrochemical Industry Co.,Ltd. (TPI)	PS	15,000
Huntsman/Mitsubishi	PS	25,000
Pacific Plastic Co., Ltd.	PS	55,000
Thai Petrochemical Industry Co., Ltd. (TPI)	ABS	22,000
Eternal Resin Co., Ltd.	ABS	8,000
Siam Sichang Co., Ltd. /TPI	Caprolactam	100,000
Thai Alkylate Co., Ltd.	LAB	40,000
Thai PTACo., Ltd.	PTA	350,000

Typical products made from various plastic resins areas follows.(5).

1. High Density Polyethylene (HDPE)

- bottles for medicine, foodstuff, and shampoo
- petrol tanks, chemical tanks
- plastic pipes and joints
- insulation for electrical wire and cables
- household gas and water pipes
- shopping bag
- hot foodstuff bags
- rope, net, mesh

Table 1.3 Consumption of plastic pellets or resin in Thailand (1982-1987)

Unit: Ton

Year	LDPE	HDPE	PVC	PP	PS	Total	%Growth
1982	49,900	33,200	46,658	49,600	13,000	192,358	---
1983	55,200	33,900	57,960	54,300	14,000	215,306	±11.9
1984	59,200	36,300	60,845	59,600	15,000	230,945	±7.3
1985	63,400	38,900	64,982	65,300	16,000	248,582	±7.6
1986	69,100	40,600	70,181	71,600	17,120	268,601	±8.1
1987	74,100	43,500	75,797	78,500	18,318	290,214	±8.0

Table 1.4 Projected rate of increase in resin demand (1988-1996)

Unit: %

Year	PE	PP	PVC	PS	ABS
1988	15.03	13.41	18.63	14.89	23.39
1989	14.50	12.94	17.96	14.37	22.53
1990	14.08	12.57	17.43	13.95	21.85
1991	14.50	12.94	17.96	14.37	22.53
1992-1996	10.50	8.99	12.40	9.97	15.46

Table 1.5 Imported-Exported Plastic Pellets or Resins in 1991

Type of Plastic	Import		Export	
	Quantity (kg)	Cost (baht)	Quantity (kg)	Cost (baht)
LDPE	44,400,172	1,122,808,249	374,334	9,388,095
HDPE	55,115,136	1,370,619,164	10,923,460	250,664,740
PP	118,379,512	2,623,084,092	4,054,250	97,868,348
PP COPOL	19,632,569	616,861,529	386,125	12,399,399
FOAM(PS)	6,892,885	248,063,404	131,100	3,977,538
PS	24,429,888	782,668,935	8,337,890	211,429,109
SAN	5,026,176	187,672,081	568,520	16,023,881
ABS	23,308,016	995,729,024	541,959	22,901,220
PVC	56,246,102	1,286,278,136	16,363,824	282,579,072
PMMA	1,889,006	109,711,173	15,000	220,838
PC	1,804,161	149,557,192	910	119,058
PET	2,013,884	78,894,073	2,349,379	59,459,420
MELAMINE	3,707,333	195,266,809	375,546	16,594,284
PHENOLIC	8,584,822	334,341,066	225	40,189
PU	2,955,232	243,314,329	624,956	34,187,069
SILICONE	1,939,053	239,375,896	24,799	2,101,282

Table 1.6 Imported-Exported Plastic Pellets or Resins in 1992

Type of Plastic	Import		Export	
	Quantity (kg)	Cost (baht)	Quantity (kg)	Cost (baht)
LDPE	37,894,823	1,101,024,808	2,148,729	46,398,573
HDPE	40,496,114	1,086,134,366	28,692,480	584,425,205
PE	31,513,369	798,326,153	48,852,332	940,996,322
PP COPOL	18,479,721	673,570,261	346,250	6,470,740
EPS	5,210,884	195,071,018	843,440	19,600,213
PS	27,902,537	925,010,355	12,168,300	256,509,340
SAN	7,507,420	253,047,509	12,225	585,429
ABS	23,155,478	1,016,766,013	21,458,300	479,012,223
PVC	75,529,405	1,588,058,659	17,138,581	275,403,156
PMMA	1,275,653	77,062,223	32,000	492,420
PC	2,202,700	194,320,637	13,554	1,418,513
PET	3,088,959	106,908,946	1,889,253	45,523,771
PA	1,687,525	482,593,956	41,845	1,986,869
MELAMINE	4,291,040	248,089,007	119,426	5,212,286
PHENOLIC	9,047,353	346,282,147	24,301	265,661
PU	4,910,781	367,006,641	-	-
SILICONE	2,143,922	304,376,958	43,162	1,558,130

2. Low Density Polyethylene (LDPE)

- plastic bags for frozen food
- kitchenwares
- plastic bags for industrial use
- multi - purpose bags, hot and cold foodstuff bags
- plastic flowers
- plastic sheets for basin lining
- toothpaste tube

3. Poly vinyl chloride (PVC)

- pipe, hoses, and joints
- vegetable oil bottles
- chemical pipes for industrial use
- insulation for electrical wire
- plastic sheet for basin lining
- artificial leather
- floor rubber sheet
- household rubber sheet tent
- shoes

4. Polypropylene (PP)

- toys
- carpet fabric
- clothing bags
- kitchenware
- fertilizer bags
- drinking straws
- wire insulation and cables
- batteries

5. Polystyrene (PS)

- insulation board
- shapes for packaging
- coffee cups
- egg cartons
- meat trays

6. Poly ethylene terephthalate (PET)

- soft drink bottles
- vegetable oil bottles
- film
- ovenable trays
- coating for ovenable board
- sheeting (for blisters, etc)
- strapping

1.2 State of Problem

The advantage of plastic is very extensive, especially in packaging and molded products. As a result of the rapid development of the plastics industry and the widening of plastic's areas of application, an ever-increasing discharge of wastes has brought an urgent need for the recycling and re-utilization of raw material. Plastics are non-biodegradable so they are serious environment pollutant. Source reduction and recycling are positive step to reduce the amount of that material in the solid waste stream. At present, local plastic wastes are recycled into pellets. These recycled pellets are than fabricated into various plastic products, mainly, bowls, basins, baskets, containers, etc. These articles normally will not last long service, because of



inferior mechanical properties of recycled pellets. Then the broken plastic articles return to waste once more.

1.3 Purpose of the Research

In this research, plastic wastes are regarded as a raw material resource. Instead of making bowls, basins and baskets, recycled pellets should be used to make permanent products. For an investor to invest in manufacturing a product, he must be confident of his raw material supply, both on quality and quantity. To use recycled pellets as raw material, one must know not only the quantity, but more importantly, their mechanical properties and consistency of these properties. The purpose of this research is to provide local investors with relevant data for their feasibility study.

This research work includes :

1. To study mechanical properties and the change of properties of plastic pellets or resins that made from plastic waste.
2. To study quantity and type of plastic waste .
3. To study feasibility of recycling plastic waste to obtain maximum benefit.
4. To study the structure of plastic recycling industries' activities.

1.4 Scope of the Research

This work will focus on plastic waste consisting of post-consumer bottles. These plastic bottles are made primarily from HDPE, PP, and PS.