NEW GENERATION POLYOLEFINS

VOLUME 7 ISSUE 4 FEBRUARY/MARCH 2002

Project Team

CMR STAFF

innovene
polyethylene and polypropylene technologies for licensing

bp

CONTENTS..,

Chemical Market Resources, Inc.
1120 NASA Road 1, Suite 340, Houston, TX 77058
Tel: (281) 333-3313 Fax: 333-3361 Web:CMRHouTex.com

CMR
Chemical Market Resources, Inc.

BP's Innovene Polypropylene Technology

BP acquired the polypropylene process technology as a result of the BP Amoco merge. Formerly known as the Amoco or Amoco-Chisso process, the Innovene PP technology was developed by Amoco, in conjunction with Chisso Corporation, in the 1970s. Amoco and Chisso collaborated on PP technology for about 25 years in both slurry and gas phase processes until mid-1995, when the relationship dissolved. Both parties retain the rights to license the process technology, however, Chisso's rights do not include recent improvements in the process claimed to be made by BP. The first full-scale plant went online at BP's Chocolate Bayou, Texas site (then Amoco) in 1979.

Currently, BP operates over 900 kT per year of the technology at the following sites: Chocolate Bayou, Texas (620 kT) and Geel, Belgium (280 kT). Another 1,700 kT per year capacity is operated/under construction by licensees around the world (DSM has three licenses, Sinopec has three, and Chemopetrol has one). See Exhibit 1.

PROCESS TECHNOLOGY

BP's polypropylene technology is a gas phase technology that employs a horizontal-bed reactor with mechanical agitation. The process is claimed to feature (1) advanced reactor design configuration, (2) high performance catalyst system, (3) competitive investment and operating costs, (4) broad product range capability, and (5) efficient and reliable operation.

The unique horizontal-bed reactor configuration is claimed to operate in a similar manner as 3 or more back-mixed reactors in series for the residence time distribution of powder. The design provides for maximum catalyst efficiency, rapid grade transitions, and minimal fines, enabling the production of polymers with high quality and consistency. Furthermore, due to fast transition times, less off-grade material is produced during product switches.

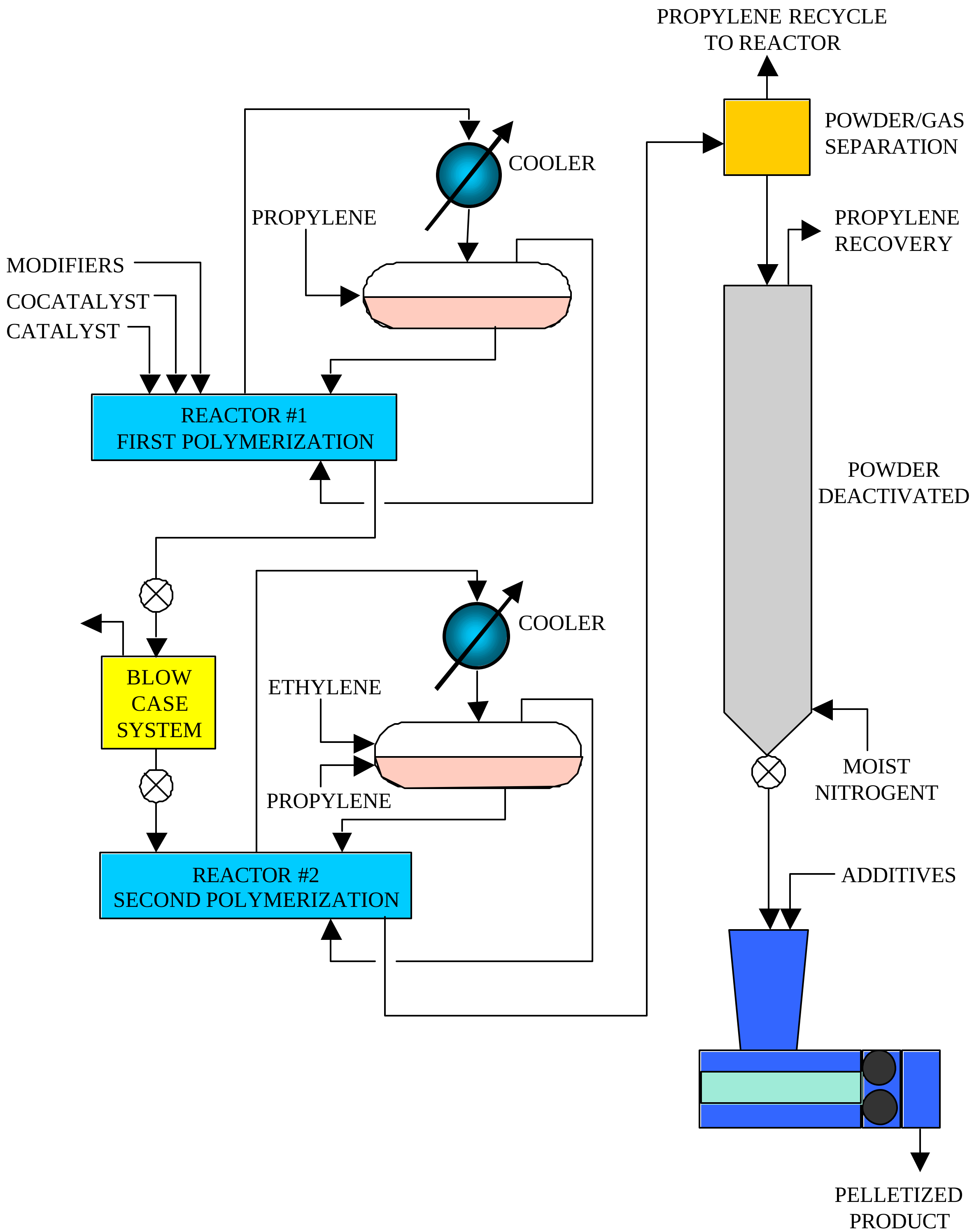
The Innovene PP process employs the CD catalyst technology, developed in-house by Amoco. The same catalyst is used in manufacturing all product grades for injection molding, blow molding, fibers, films, and sheet applications. The catalyst has the following features: (1) highest catalyst activity for maximizing of reactor throughput, (2) controlled morphology, (3) less fines, and (4) ability to tailor stereo-regularity.

The process claims to have competitive investment cost as a result of the simple process design coupled with the high activity CD catalyst. The operating costs are also lower due to less steam and power consumption, lower maintenance cost, and rapid grade transition.

The technology is capable of making a full range of products: (1) Homopolymers with a wide range of melt flow rates and stereo-regularity, (2) Random copolymers with a wide range of comonomer content, (3) Impact copolymers with excellent balance of stiffness and impact. BP claims that although the technology allows for rubber content as high as 30%, its impact copolymers do not need as much rubber to achieve performance characteristics comparable to high rubber loaded products sold by competitors. BP attributes this to the manner in which rubber is formed (*i.e.*, inside-out) in the growing polymer particle. The rubber content in commercially available products ranges from 17%-20%

Chemical Market Resources, Inc.
Tel: (281) 333-3313 Fax: 333-3361

Exhibit 2 – Innovene PP Technology Process Diagram



Source: Chemical Market Resources, Inc.

Chemical Market Resources, Inc.
Tel: (281) 333-3313 Fax: 333-3361

Finally, China Attains its Ultimate 15-year Old Goal

In November 2001, China ended its 15-year quest to enter the 142-member World Trade Organization (WTO). With this newly acquired membership, China will be weathering a challenging economic transition in the midst of a stagnating global economy. China's dragon gates will now be fully opened to the international community and that means increasing scrutiny in its internal trade policies and business practices. Its inauguration into the WTO will undoubtedly mark a turning point in the economic and political climates.

IMPLICATIONS

Since China is still classified as a developing country, it is entitled to several privileges such as protection of export subsidies for infant industries and elastic stipulations on the tariff system. The Chinese government will retain their rights to control certain markets in order to protect domestic interests. For instance, the government will continue to impose a 25% import tax on automobiles for a six-year period and the agriculture sector will mainly be franchised by the government. China will have the exclusive right to adopt these exceptional clauses if its infant industries are threatened substantially by foreign competition.

Globalization is ultimately the focal point of China's economic strategy following its WTO accession. There will be significant progression in diversifying its markets by forging closer bilateral ties with Eastern Europe, Latin America and America. China will simultaneously boost its established relationships with neighboring Asian countries. They will also enjoy preferential tariff rates in certain countries thus facilitating its penetration into foreign markets.

China can now be an active participant in formulating regulations, exercising its opinions and negotiating initiatives to strengthen Asia's economic position as a whole. Instead of being a passive bystander, China's status will be notably elevated with active participation at the next WTO convention. As China widen its doors to the world, this will accelerate their integration into international trade and hasten modernization of its enterprise system. China will also capitalize on its WTO membership to steer itself away from the current import-export deficit situation to a more export-oriented country. Accession to the WTO would provide for more stable trade relations with other members, including the United States. It is vital that China closely adheres to the international regulations set by the WTO, as foreign investors will use this as a basis to build up their confidence in China's capability to implement decisions in accordance to these rules. Once this confidence has been imbedded in the international community, this will pave a smoother route for China's market accessibility into foreign countries.

IMPACT ON THE CHEMICAL INDUSTRY

The local chemical industry has a general positive outlook on China's WTO accession. The general sentiment in the chemical industry conveys a more optimistic attitude towards foreign investors rather than apprehension over competition. This can be attributed to the industry's early acceptance of technological and financial contributions in terms of joint ventures from foreign companies. Therefore, the impact on the chemical industry is not expected to be dire.

Chemical Market Resources, Inc.
Tel: (281) 333-3313 Fax: 333-3361

China's Polyolefins Industry

Overview of China's Polyolefin Industry

The polyolefin industry in China is considered to be in a developing phase and has made notable progress especially since the implementation of the Seventh-Five Year Plan. This industry was considered unique in that it was one of the very few industries in China, which initiated a more open environment to foreign investments, technology and managerial style. There was much government intervention in the petrochemical industry traditionally but the China Plastics Processing Industry Association (CPPIA) has taken over this role.

This article discusses the major developments in the Chinese polyolefin industry, market trends, the restructuring and reforms that have taken place and the projections for this market sector.

Major Players in the Polyolefin Industry

The two petrochemical giants in China, namely, SINOPEC and China National Petroleum Group (CNPC) are the principal players in the polyolefin market, accounting for a combined 90% of China's petrochemical intermediates and downstream products. Exhibit 1 shows the locations of the major polyolefin manufacturing facilities in China.

Their market shares in PE, PP and PVC are illustrated in Exhibit 2-3.

Exhibit 2
Market Shares of PE Producers in China, 2001

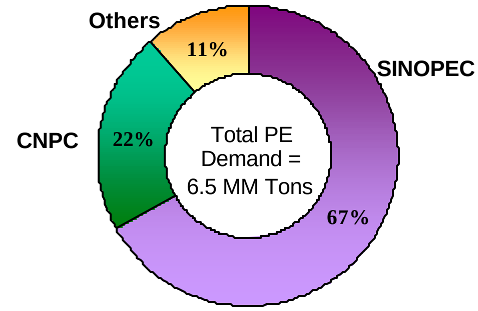
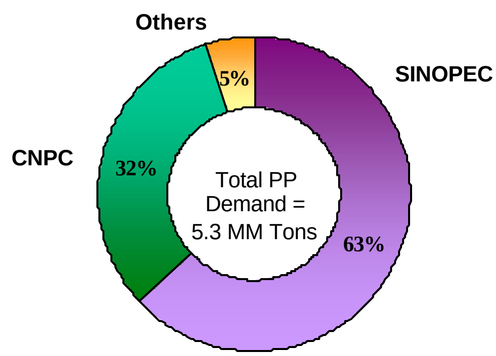


Exhibit 3
Market Shares of PP Producers in China, 2001



Major Developments in a Decade (1991-2001)

During the 1990s, demand for polyolefins far exceeded domestic supply despite aggressive expansions by local producers. As a result, China relied heavily on imports since domestic production contributed only 50% of the market demand. The following three sections will cover the Eighth-, Ninth- and Tenth-Five Year Plans specifically relating to the polyolefin industry in China.

Chemical Market Resources, Inc.
Tel: (281) 333-3313 Fax: 333-3361

Business Strategies for Commodity Suppliers

Objective

In today's competitive environment companies have started building core competencies that revolve around competing in global markets. The key to success in global markets lies in the ability to identify the course of shifting demand around the globe. This ability to recognize potential growth in different geographic regions will allow the suppliers to be proactive than reactive. The suppliers can then catalyze the evolutionary path of growth by fueling demand through capacity building and marketing efforts. CMR, based on its experience in numerous global studies, has developed a methodology that helps in gauging the potential market in various regions. The objective of the article is to present this methodology by evaluating the global markets for bi-axially oriented polypropylene (BOPP) films.

Introduction

This methodology uses the comparative analysis of per capita consumption as a tool to recognize the true market potential of a material in different geographic regions. Once the true potential for each region has been assessed the business strategy addressing the global markets can be developed.

Methodology

The example of BOPP films has been used to understand the methodology. The various steps involved in the analysis include

1) Calculating the per capita demand for BOPP films in different regions.

2) Estimating the growth rate for BOPP films in each region.

3) Plotting the per capita demand for each region against projected growth rates.

Calculating the per capita demand

Exhibit 1 presents the per capita demand in pounds for BOPP films in all the regions. India and China are not included in Asia as they are densely populated and therefore their per capita consumption would be different than the per capita consumption for rest of Asia. Japan is also taken separately as its markets behave differently compared to rest of Asia.

Exhibit 1

Per Capita Consumption by Region

Region	Per Capita Consumption
Japan	5.06
North America	2.48
Western Europe	1.43
China	0.87
Eastern Europe	0.66
South & Central America	0.47
Rest of Asia/Pacific	0.41
Africa/Middle East	0.39
India	0.11

Estimating the growth rate

After calculating the per capita consumption for each region, growth rates are needed for each region. Growth rates for the region can be obtained from internal data, publications, or consultants specializing in market research. Chemical Market Resources, Inc. has estimated the growth rate for BOPP films in different regions based on consultations with producers and end-users of BOPP films. **Exhibit 2** presents the

Chemical Market Resources, Inc.
Tel: (281) 333-3313 Fax: 333-3361

Chemical Market Resources, Inc.
Tel: (281) 333-3313 Fax: 333-3361

PolyTrac
Capacity Tracker

Worldwide HDPE by Technology

Upcoming Polymers

Apr '02	PP
Jun '02	EP(D)M
Aug '02	PVC

CMR
Chemical Market Resources, Inc.
Tel: (281) 333-3313 Fax: 333-3361

PolyTrac
Company Profiles

Mitsui Sumitomo

Upcoming Profiles

Apr '02	Reliance
Jun '02	DSM
Aug '02	Shin-Etsu

CMR
Chemical Market Resources, Inc.
Tel: (281) 333-3313 Fax: 333-3361

Value in End-Use Analysis – Trash Can Liners

Objective

The overall objective of this article is to analyze and compare the value chains for trash can liners made from LLDPE and HDPE resins. This article will present a brief overview of the markets for trash can liners, followed by the comparison of the cost structures and value chains for trash can liners produced using LLDPE and bimodal HDPE resins.

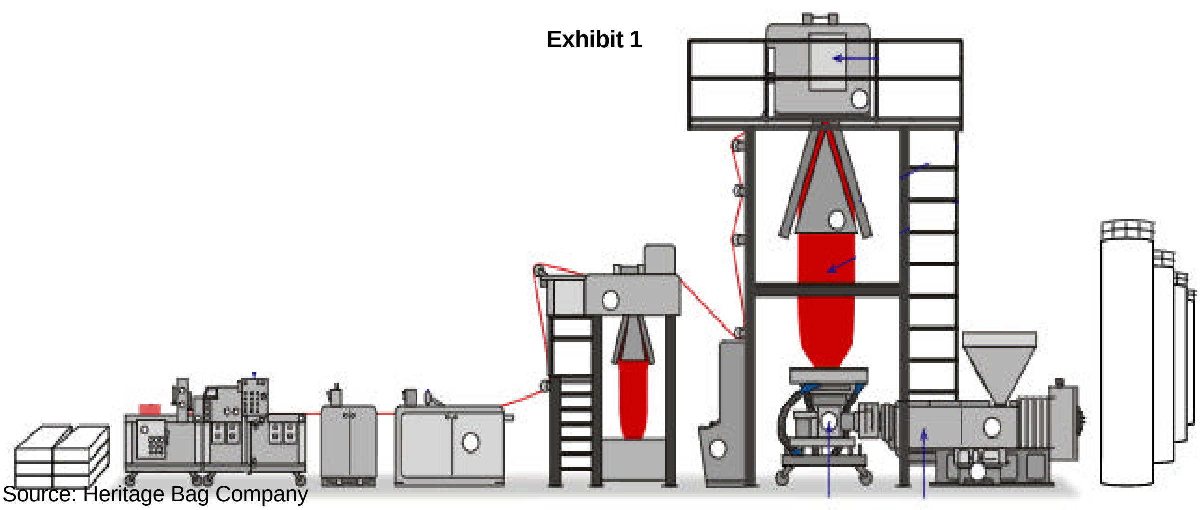
Introduction

The trash can liners market can be divided into consumer liners and industrial liners. Consumer trash can liners typically include trash can liners that are marketed in retail establishments such as grocery stores, supermarkets, convenience stores, and discount department stores. Institutional trash can liners can be described as the can liners typically used by municipalities, private businesses, and public institutions such as schools, hospitals, health care centers, restaurants, and state and county agencies and bureaus. Historically, the dominant resin used in the manufacturing of trash can liners has been LLDPE. However, trash can liners made from HMW-HDPE have also gained market shares in recent years. This shift can be attributed to the introduction of bimodal HDPE resins that have enabled the trash bag manufacturers to downgauge without compromising the strength of the bag.

Manufacturing Technology

LLDPE and HDPE are the most commonly used resins for the manufacture of trash can liners. The thickness of can liners made from LLDPE resins ranges from 0.40 mil to 2.00 mil while the thickness of can liners made from HDPE resins ranges from 0.25 mil to 0.65 mil. **Exhibit 1** presents the major steps involved in the manufacture of trash can liners. The resin is first conveyed from railcars to the storage silos into hoopers that feed the extruder. The extruder then melts the polymer and passes it on to the die that forms a ring of the polymer. The ring of the

Exhibit 1



Source: Heritage Bag Company

Chemical Market Resources, Inc.
Tel: (281) 333-3313 Fax: 333-3361

ATOFINA Commercializes Syndiotactic Polypropylene

ATOFINA began commercial production of the metallocene based Finaplas®-brand PP resin last month, after several years of developmental and commercialization effort. It is estimated that the first-year production will be limited to 8-10 million pounds.

The metallocene polypropylene activities of ATOFINA Petrochemicals sprang from the research activities of Petrofina and Fina Oil and Chemical Company. Fina was the pioneer in syndiotactic polypropylene, producing it initially on a commercial line in 1993 and eventually selling it semi-commercially under what many assumed is the trade name, EOD. In actuality EOD stands for Experimental Operational Directive and is merely the prefix for experimental runs, not the brand name.

The brand name for the commercial products is Finaplas. ATOFINA produces sPP on one of the smaller Fina bulk loops, located at La Porte, that has a capacity of 40 million pounds.

Metallocene-based polypropylenes have a narrow MWD and are characterized by having lower levels of extractables and lower melting points than their conventional counterparts. Polypropylene mechanical properties are a strong function of the overall tacticity of the polymer chains.

Syndiotactic polypropylene differs markedly from the isotactic version though their empirical compositions are identical. Whereas isotactic polypropylene is a stiff material, syndiotactic polypropylene, because of its syndiotacticity, has a much lower flexural modulus and melting point. The backbone chain is very flexible, and the syndiotactic configuration of the methyl groups results in a very dense array of molecular entanglements. This greatly affects the kinetics of crystallization and recrystallization, resulting in unusual, time-dependent changes in the polymer; *e.g.*, mechanical properties change markedly over the first few hours after a part is formed, and the material stiffens considerably on aging at ambient temperature. The barrier and heat-seal properties of sPP change over time.

Syndiotactic polypropylene is more resistant to γ-radiation than is isotactic polypropylene, a feature that may make it especially useful for medical products where γ-irradiation is becoming the standard method for sterilization. Syndiotactic polypropylene has a lower level of crystallinity, making it less prone to damage.

Finding applications for sPP has been a slow process because the novel crystallization kinetics makes it a difficult material to handle after processing. However it is a startlingly transparent material that is beginning to find acceptance in certain market niches when blended with other polyolefins.

Exhibit 1 provides performance data on the four commercially available grades. The product slate consists of all random copolymers with MFR ranging from 2 to 25.

The products with the lowest MFRs are recommended for use in film and sheet applications. The 8 and 10 MFR grades can be used in cast- and blown-film operations. The 25 MFR grade can be used in injection-molding and fibers applications. The main target applications are in films and sheet, primarily shrink films. Some applications in medical tubing are also being considered.

CMR
Chemical Market Resources, Inc.
Tel: (281) 333-3313 Fax: 333-3361

TRADE-OFF ANALYSIS

INTRODUCTION

Most polyolefin-based products used in end use applications are selected based on a trade-off of product performance vs. cost in the end use. In products that are based on total use, the cost is directly related to the price. This is our attempt to select one end use per issue and quantify the trade-off analysis.

TRADE-OFF ANALYSIS

The attributes that are commonly used for comparing the performance of a product can be classified as: (1) Product Supply Attributes, and (2) Technical Attributes.

The product supply attributes address the issues related to the price, supply, and services, and afford excellent means of comparing similar or same products supplied by two different companies.

The technical attributes are usually means of comparing two different products *(i.e.* PVC vs. Polyolefin's) and or two different types of polyolefin's (*i.e.* octene vs. hexane) for a particular application. The technical trade-off analysis is also an effective means of developing new products for existing end users.

Chemical Market Resources, Inc. based on our extensive experience has conducted numerous trade-off analysis over the last ten years. This is our attempt at presenting the methodology and examples of trade-off analysis.

Since majority of the technical trade-off analysis we conducted are proprietary for the individual clients, we will discuss the methodology for the product supply trade-off analysis only.

PRODUCT SUPPLY ATTRIBUTES

Based on our analysis and discussions with the major end users, the following attributes were considered.

- Product Quality
- Product Line
- Technical Services
- Product Delivery
- Price

Of all the attributes under consideration, price is the most important criteria – because under the basis of economic principles, consumers will always prefer the lowest price given all the other attributes are satisfied first. Hence price has to be discussed independent of all the other attributes and will influence the rest of the attributes.

CONDUCTING A TRADE-OFF ANALYSIS

The steps involved when performing a trade-off analysis are as follows:

- Identifying Customer Preferences
- Quantifying Customer Perception
- Normalizing the Data
- Analyzing the Data

CMR
Chemical Market Resources, Inc.
Tel: (281) 333-3313 Fax: 333-3361

TRADE OFF ANALYSIS OF SBCs Application – Kraton Polymers versus EniChem.

Objective

In the midst of the chaos and competition between the suppliers, one often forgets the center of attention "The Customer". It is the customer who decides what products to buy and from which company. Therefore a supplier who wants to gain higher market shares or even retain their current customers has to make a distinct effort to understand the customer. A supplier with the knowledge about the perceptions and requirements of the customers always leads the market.

In this article of NGP, the objective of the analysis is to understand the customer's perception of quality and price.

Further we intend to present an analysis that addresses the following issues:

- Market perception analysis of suppliers
- Comparative performance of two suppliers
- Met/Unmet needs of the end users

Introduction

Styrene Block Copolymers (SBCs) belongs to the family of thermoplastic elastomers (TPE'S). The five distinct types of TPEs include (1) SB copolymers (SBCs), (2) thermoplastic polyolefin elastomers (TPOs), (3) thermoplastic polyurethane (TPUs), (4) copolyester elastomers (COPE) and (5) thermoplastic polyamide elastomers (TPAs). SBCs due to their molecular orientation exhibit unique properties and have excellent elastic, physical, mechanical properties, and processability.

SBCs were first discovered by Shell Chemical Company in the early 1960s. The manufacturing of SBCs was started by Shell and Phillips Petroleum in the same decade.

The total global demand for SBCs in 2001 was 1,830 MM Lbs. SBS accounts for 75% or 1,360 MM Lbs, SIS accounted for 14% or 260 MM Lbs and SEBS accounted for 11% or 210 MM Lbs.

Types of SBCs

There are four major types of SBCs *i.e.*

- Styrene-Butadiene-Styrene (SBS)
- Styrene-Isoprene-Styrene (SIS)
- Styrene-Ethylene-Butylene-Styrene (SEBS) and
- Styrene-Ethylene-Propylene-Styrene (SEPS)

Styrene-Butadiene-Styrene (SBS) are unsaturated triblock polymers. SBS has the highest worldwide consumption in terms of volume compared to other types of SB copolymers. SBS are manufactured by sequential polymerization of styrene and butadiene. The major end-use markets for SBS include (1) footwear, (2) road pavement (asphalt modification), (3) roofing (modified bitumen roofing) (4) adhesives and sealants, (5) polymer modification, and others

Styrene Isoprene Styrene (SIS) are also unsaturated triblock polymers that are manufactured by sequential polymerization of styrene and butadiene. The major market for SIS is pressure sensitive adhesive.

CMR
Chemical Market Resources, Inc.
Tel: (281) 333-3313 Fax: 333-3361

END USER FOCUS: POLYONE CORPORATION

INTRODUCTION

In this issue of **New Generation Polyolefins**, (NGP) we will be covering the PolyOne Corporation, one of the leading suppliers of performance plastics in the world.

PolyOne Corporation, headquartered in Cleveland, OH, was formed on August 31, 2000, as a merger between The Geon Company (Geon) and M.A. Hanna Company (Hanna).

PolyOne is the largest polymer services company in the world offering (1) thermoplastic compounds, (2) specialty polymer compounds, (3) engineered films, (4) color and additive systems, (5) elastomer compounds & additives and (6) thermoplastic resin distribution.

The company operates in four business segments namely (1) Performance Plastics, (2) Elastomers and Additives, (3) Distribution, and (4) Resin and Intermediates.

PolyOne has over 9000 employees at its 80 manufacturing sites in North America, Europe, Asia and Australia with total annual revenues of $ 3.5 billion.

HISTORICAL DEVELOPMENTS

Exhibit 1 presents an overview of the historical developments related to **PolyOne Corporation.**

PolyOne Corporation was formed on August 31, 2000, as a merger between M.A. Hanna and Geon. Therefore in this section we will be covering separate histories of M.A. Hanna and Geon, which is needed in order to understand the past and future direction of PolyOne Corporation.

M.A Hanna

Marcus Alonzo Hanna founded the company in 1858 under the name M.A. Hanna.

During the next three decades, the company established itself as a major supplier of iron ore, pig iron and coal.

By 1920, the company had established itself as a corporation and a public company. Its portfolio of businesses included mining, transportation and steel operations, and investments in oil, tobacco and banking.

During the 50s, the company restructured itself into The Hanna Mining Company and The M.A. Hanna Company, a closed end investment firm.

In 1985, the company formed a strategy to diversify its assets into other businesses. This was largely due to the overall decline in the US steel industry. As a result the company dropped its name The Hanna Mining Company renamed it as M.A. Hanna.

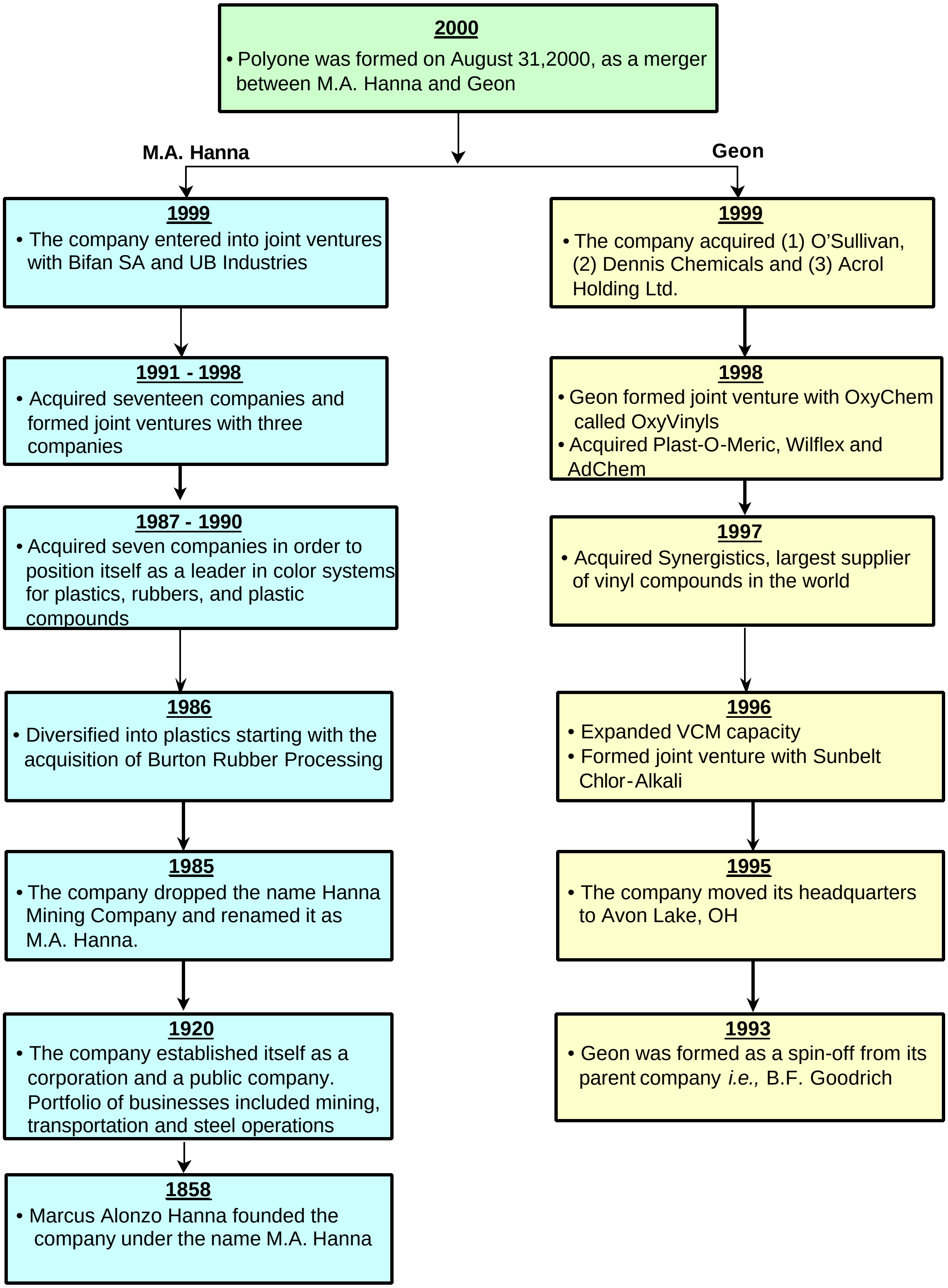
In 1986, the company acquired Burton Rubber Processing, making it the first acquisition in its portfolio diversification strategy.

From 1987 to 1990, the company acquired seven companies in order to establish itself as a leader in color systems for plastics, rubbers, and plastic compounding; and distribution of engineered plastic and plastic resins.

Chemical Market Resources, Inc.
Tel: (281) 333-3313 Fax: 333-3361

Exhibit 1

HISTORICAL DEVELOPMENTS: POLYONE CORPORATION



Source: Chemical Market Resources, Inc.

News Watch!

Everything You Need to Know to Succeed in Polyolefins

♦ Basell to Sell PP Compounding Facility.

Basell is set to sell its polypropylene compounding plant to Alloy Polymers, Richmond. The plant has a capacity of 50,000 ton/year and is located at Gahanna, OH. As part of the deal Alloy polymers will toll compound for Basell for four years.

♦ Dow to Close Ethylene Plants in Texas.

The Dow Chemical Company is expected to close two ethylene plants it inherited from its merger with Union Carbide. The move is expected to be around 2005-2006 about the time they have to meet NOx emission mandate. The plants are ethane crackers and a have a combined capacity of 2.475 billion pounds a year.

♦ Explosion at ExxonMobil's Polyethylene Line in Belgium.

In Belgium near Antwerp, an explosion occurred that disrupted ExxonMobil's 300,000 mt/yr polyethylene production.

ExxonMobil feeds ethylene to this unit from its Antwerp joint venture cracker with Atofina.

♦ Atofina Commercializes Syndiotactic Polypropylene.

Atofina Petrochemicals have started the world's first commercial production of metallocene syndiotactic polypropylene (sPP). Atofina has converted a 40 million pounds per year polypropylene line to produce sPP. Production is set at 6 million lb/year and is set to increase to 30 million lb/year in five years.

Syndiotactic polypropylene gives a very high clarity compared to conventional or metallocene isotactic PP and does not require the use of separate clarifiers. Syndiotactic polypropylene accounts for 2%of Atofina's total polypropylene output.

♦ PKN Orlen to Debottleneck PP Unit.

PKN Orlen, a Polish state oil and petrochemical manufacturer will carry out debottlenecking its polypropylene unit at Plocak. The move will bring PKN Orlen PP capacity to 130,000 mt/yr.

Poland's main export market for polypropylene is neighboring countries like Slovakia and North Western Europe.

♦ Qatar Petroleum and Atofina to Form a JV for Ethane Cracker

Qatar petroleum and Atofina are in negotiation to finalize a plan to form a joint venture (Qatarfin) to build a world-scale ethane cracker at Ras Laffan, Qatar. The unit will have an ethylene production capacity of 1.1 million m.t./year.

Chemical Market Resources, Inc.
Tel: (281) 333-3313 Fax: 333-3361