SPECIALTY/ VALUE ADDED POLYOLEFINS – PERPARING FOR THE UPCOMING GLOBAL RACE

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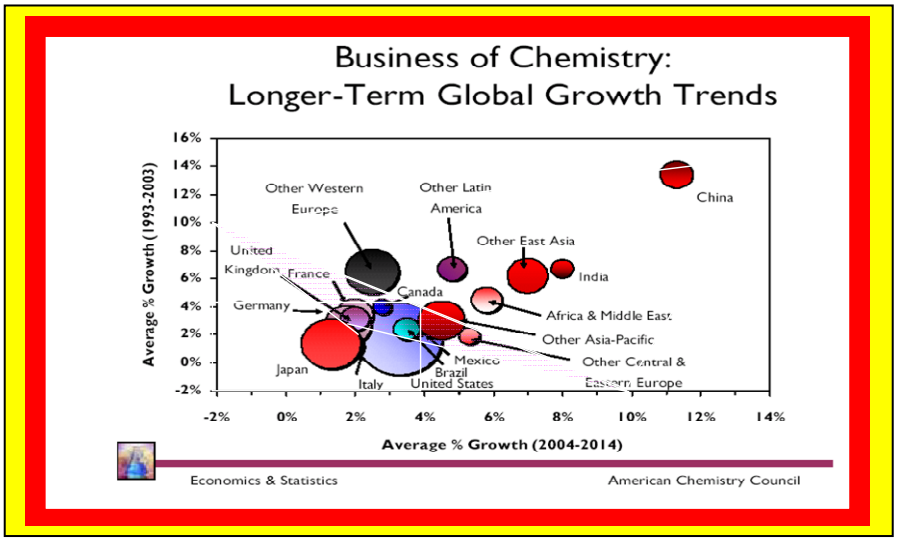
INTRODUCTION

The Global petrochemical industry is undergoing major changes speeded up by the IT and information technology.

Exhibit 1 presents the current and future growth of petrochemical industries.



The World is following a natural growth pattern - of people, resources. and living standards - speeded up by the IT revolution. There are no winners or losers. Just the DYNAMIC CHANGES. Organizations that adopt to changes will always thrive.

The industry players have few choices - Just join in the band wagon.. Or end up cleaning the confetti.. The choice is yours –

These changes are brought on by

The Global petrochemical industry is changing because of the following trends:

1. Changes n NaturalGas/Naphtha per BTU Value
2. The developments in resource rich nations that are permitting them to capture more value
3. The changing Global political and demographic trends

All three have a major impact on the tuture product process migration trends Globally.

Most of the industry players have heard the forecasts that unanimously agree on the following items – In the next ten years:

1. Middle-east with its low feedstock advantage will become the manufacturing hub for the petrochemicals and plastics.

2. China, followed by India and other ASEAN countries due to their higher GDP growth will be the main consumers for the traditional petrochemicals and plastics

3. Facing lower growth and lower need for new capacities, the US Gulf coast, Japan and China will face pressures in the future.

Now, let us look at some additional scenarios.

The current growth in China will is in two specific areas – imports to meet the growing domestic demand and China's desire to reach self-sfficency in raw materials and level I products by 2012.

These two issues will increase pressure on the current suppliers to China to develop alternative markets by 2012 – 2015.

India's knowledge based economy combined with uneven emphasis on cracker plus 2 products –dominated by one player is sure to head towards disaster, because of the downstream industry bottleneck.

India has the consumption growth, without processing capability. Hence most of the petrochemicals produced in India will have to be exported, so they can comeback as the consumer goods back to India – thus putting more pressure on the current players enjoying the Chinese Gold rush.

All these issues will send the whole world towards one direction Specialty and Value Added Products

Independent of Global regions – U.S, Europe, Japan, Middle East, Eastern Europe and South America – all are talking about the coming race for "Specialty Value Added Products"

In this article, we want to address/refresh our analysis from the year 2000 on polyolefins and elastomers specialty/value added products.

Polyolefins represent approximately 60% of all the thermoplastics produced and/sold in the world. The major types of polyolefins include: (1) PP, (2) HDPE, (3) LLDPE, (4) LDPE, (5) metallocene PE and PP, (6) various copolymers and (7) elastomers,

The polyolefin family of products serve a wide variety of end use markets in the major sectors of: (1) packaging, (2) automotive, (3) construction, (4) medical (5) wire and Cable and others. By nature an industry of this size is considered a commodity product.

However almost all of the major polyolefin producers consider polyolefins as a specialty product with plenty of opportunities for value addition and creation through technological innovations. A comparative review of polyolefins vs. the next largest polymer, PVC bears the fact. Unlike the incremental technological developments more common in other polymers, polyolefins technology developments are significant and routinely leap frog the existing ones. These tremendous developments in technology impact the whole industry as a unit as well as the high profit sectors, often causing confusion on expected impact on profitability and classification of specialty vs commodity. Case in point, metallocenes introduced in early 90s were initially positioned in the market as specialties with high expectations for profitability, but are settling down as the "differentiated commodities".

Historically, the chemical and petrochemical materials have been classified into commodities vs. specialties based on size, number of players and profitability as the criteria. This classification received popularity during the mid-eighties when most organizations made special effort to move to from commodities to specialties. Such a system was never used in the area of polyolefins.

OBJECTIVES

The overall objective of this article are to:

1. Present the concept of "Value" as it relates to polyolefins
2. Discuss the available polyolefins in terms of specialties vs. commodities
3. Discuss the value addition process for different types of products.

BACKGROUND

In general any industrial good goes through several steps of transformation before it reach the consumers. These transformations include, processing, converting, storage, distribution and transportation. At each step of the way additional value is added to the product.

The value concept was first used in the Victorian era commercial codes, which are still popular in England as a part of Value

Added Tax (VAT). In a simplistic sense each and every material is tracked from the raw material stage to the final stage with value added at each stage determining the tax paid by the merchant at that stage, all the way to the consumer level. This British system, though may seem cumbersome, defines value at each step for tax assessment.

Under the American system, under the Uniform Commercial Code, the taxation is based only on the final value to the consumer, making it unnecessary to track the value added at each step. The system was considered a simplification of the Victorian system. However with time, the "Value Added" concept caught on in the American industry as a measure of efficiency and profitability at different stages of manufacture and distribution. The value added concept was used to classify the materials into specialties vs. commodities.

Unlike other thermoplastics like, PVC, polystyrene, polyolefins have more options in terms of manufacturing technologies, grades and potential for customization at the manufacturer level instead of end user level (e.g., PVC). This wide variety of choices at the manufacturing level is the reason, some of the polyolefin producers consider polyolefins as specialties or in some cases value added products.

The following observations apply to polyolefins in assessing the value addition.

Since most of the polyolefin end uses with few exceptions exhibit very inelastic demand curves, any value captured in most cases is limited to converting and distribution system.

The intangible portion of the price of polyolefin end users differs depending upon end use and industry sectors – the value in end use as a means of price setting needs to be applied taking into consideration the intangible portion of the price at the end user level.

The value addition in polyolefins results from: (1) Technology development to meet a specific need – based on post-reactor processing - acid copolymers, radiation sterilizeability etc., (2) technology development to meet a wide variety of end uses using the catalyst/process developments – High EVAs, metallocenes, Hivalloy, ESIs etc. or (3) moving up and down the vertical integration – reactor compounding the capture the end use value of the compounded products – Reactor TPOs, Catalloys etc.,

Once the value is added to the product the specific profitability, distribution system and demand have a higher influence on differentiation of specialties vs. commodities.

Classical definitions of product differentiation scale include the following:

Commodities – the very large volume products that are sold by a large number of suppliers to large number of customers, with less product differentiation and price as the major criteria.

Differentiated Commodities - the very large volume products that are sold by selected suppliers to large number of customers, differentiating product based on performance and price

Large Volume Specialties – Large/medium volume products that are sold based on technology, performance and meeting end use requirements as the major criteria.

Specialties – Small volume products supplied by limited suppliers with high profit margin and high barriers to entry based on technology

SPECIALTY INDEX

To differentiate, we selected most of the polyolefin products and determined their **"Specialty Index"**

We defined the specialty index as a combination of the following major attributes and associated weights:

Attributes	Weight%
1. Profitability	40%
2. Demand	20%
3. Number of Players	15%
4. Price	15%
5. Technical Barriers	10%

On a scale of 0 to 1 with, 1 representing an ideal specialty, the following scores were used:

Profitability – defined as (Price-Manuf Cost)/Manuf. Cost. is the most important criteria in assessing the product's specialty nature.

Score	Profitability
0.00	<10%
0.25	10-30%
0.50	31-60%
0.75	61-90%
0.00	>90%

Demand – even though the product is highly profitable, the sustained demand even at low growth rates is very important to maintain the specialty status. Case in point, Syndiotactic PP, has been profitable specialty product with limited demand.

Score	Demand
0.00	>5 bn pounds
0.25	1-5 bn pounds
0.50	0.5-1 bn pounds
0.75	0.2-0.5 bn pounds
1.00	<0.2 bn pounds

Number of Players – The specialty products provide advantages to the limited players and protects the price. As the number of players increases, the specialty nature of the product decreases because factors other than product uniqueness (market share gains, service, become more important)

Score	Number of Players
0.00	>10
0.25	8-10
0.50	5-7
0.75	2-4
1.00	<2

Price of the product has been one of the better determinants in polyolefin industry because the basic raw material is still ethylene/propylene and margin over the monomer price is important measure of revenues per unit.

Score	Price
0.00	<40 cents/lb.
0.25	40-60 cents/lb.
0.50	61-100 cents/lb.
0.75	101-150 cents/lb.
1.00	>150 cents per pound

Technology Barriers have always provided the polyolefin manufactures in increasing the value of the products. However if the technology is easier to adapt and/or protection is unavailable the product tends away from the specialty nature.

Score	Technology
0.00	Low
0.25	Low/Medium
0.50	Medium
0.75	Medium/High
1.0	High

POLYOLEFIN PRODUCTS CLASSIFICATION

Following section represents a comprehensive list of all polyolefin-based products currently marketed. Our goal is to assess the specialty index of each of these products to classify them into:

1. Commodity
2. Differentiated Commodity
3. High Volume Specialty
4. Specialty

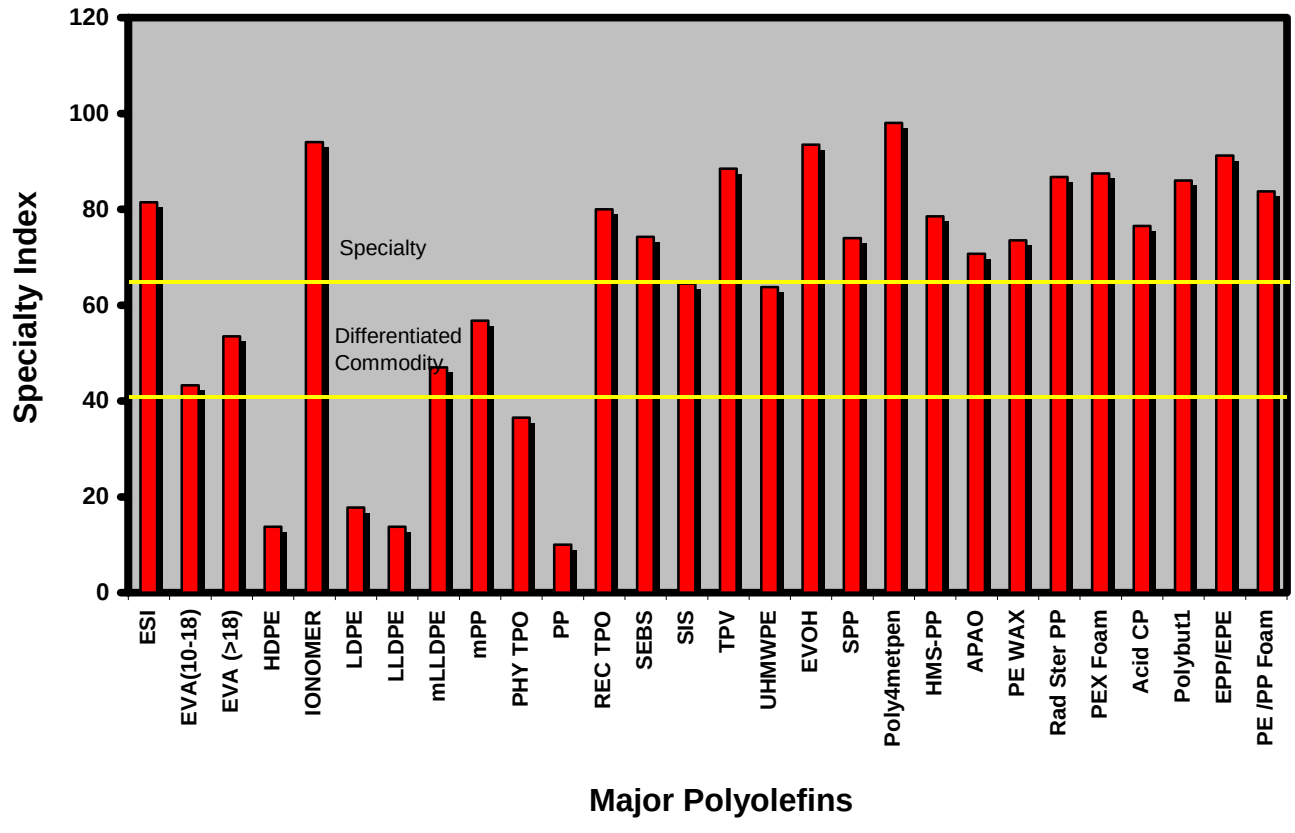
The Following products were analyzed.

1. LDPE
2. LLDPE
3. Metallocene LLDPE
4. PP
5. Metallocene PP
6. Polybutene-1
7. Poly-4 Methylpentene-1
8. HMS-PP
9. Ultra High Molecular Weight PE
10. Polyethylene Waxes
11. Amorphous Polyalphaolefins
12. Acid Copolymers
13. Ionomers
14. EVOH Polyolefins
15. Ethylene-Styrene Interpolymers
16. Radiation Sterilizeable Polyolefins
17. Crosslinkable PE
18. Expandable PP and PE Beads
19. High EVA 10-18%
20. High EVA >18%
21. HDPE
22. Physical TPO
23. TPV
24. RTPO
25. SEBS
26. SIS
27. Syndiotactic PP
28. PE/PP Foams

Exhibit 1 presents the mapping of most polyolefins based on their ranking in the specialty index. The products that qualify as specialties have a score of 60 and above.

The products that the fit the criteria include: (1) ESIs, (2) Ionomers, (3) Reactor TPOs, (4) SEBs, (5) TPOs, (6) EVOH, (7) Poly4methylpentene-1, (8) High Melt

Exhibit 1



Strength PP, (9) PE Wax, (10) Radiation Sterilizeable PP, (11) Syndiotactic PP, (12) Amorphous Polyalphaolefins, (13) Polyethylene foams, (14) Acid copolymers, (15) polybutene-1, and (16) PE.PP Beads. All of the specialty products selected provide a function, property and/or processability that the commodity polyolefins cannot provide. Thus In polyolefins, the technology is the major component that differentiates the specialty products from commodities.

Within the specialty products the profitability of the product is dictated by the process integration. As explained earlier, most of the value added is in terms of technology and process development. Since, the manufacturers and compounders add value to the products, the profitability of the manufacturers is depended on how much value they can add. The value added by the resin manufacturer is decided by the vertical integration.

Vertical Integration - To assess the relative profitability of the specialty manufacturers, we evaluated all the products that qualify to be specialty based on Vertical Integration factor.

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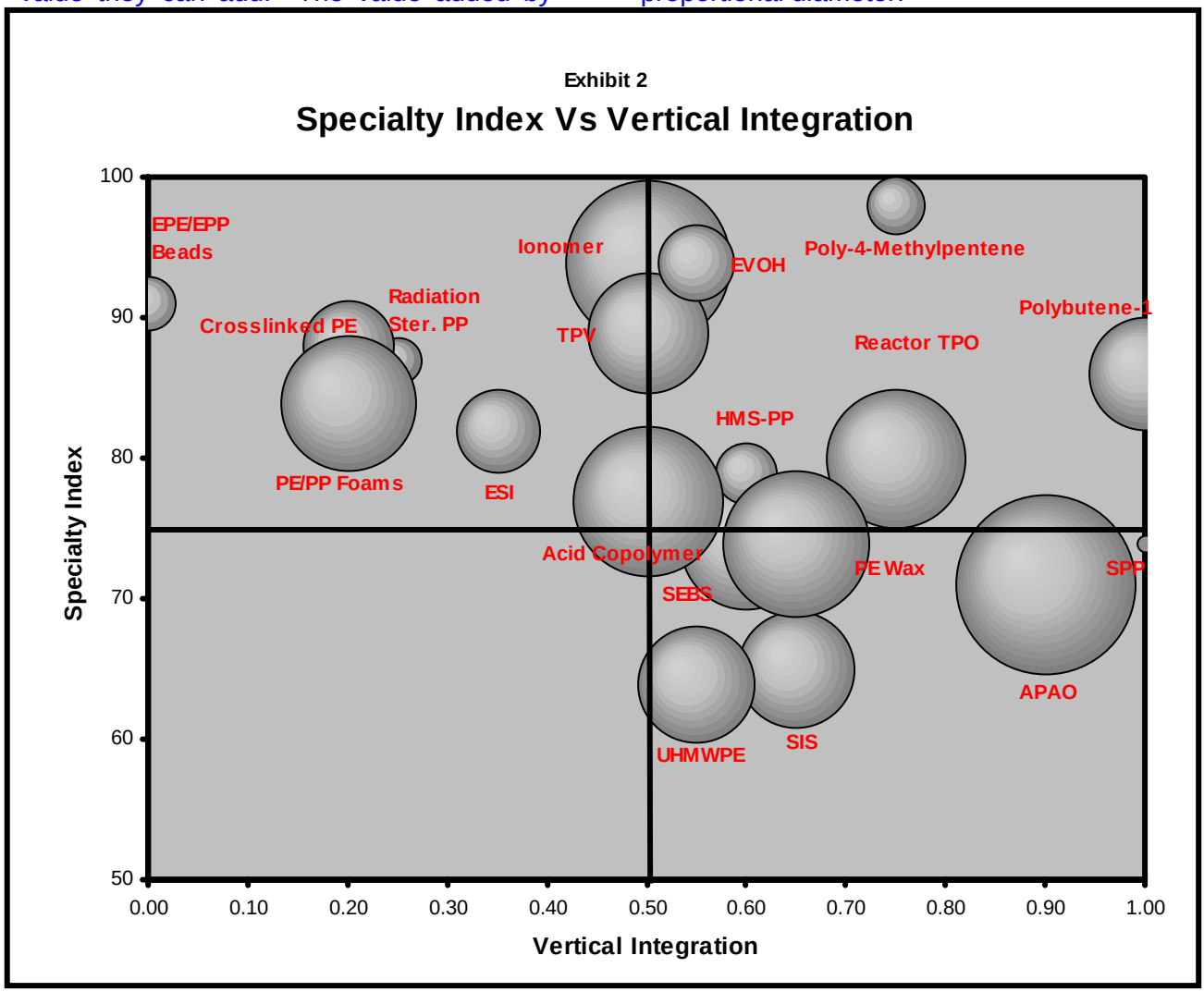
Score	Technology
0.00	Externally Compounded
0.25	Both Internal and External Compounding
0.50	Post Reactor Process
0.75	Reactor Campaign, Dedicated Reactor
1.0	Reactor Process

Exhibit 2 presents the specialty products versus the vertical integration with approximate North American size as the proportional diameter.

Exhibit 2



Most true and profitable specialty products have a higher vertical integration and specialty index. In the next article we will assess the individual profitability contribution.

EXAMPLES

High EVA Copolymers

Vinyl Acetate up to 4-6% is included in most low density polyethylenes without any perceptible impact on the performance. In most cases their presence is not identified.

The definition of High EVA copolymers is reserved for VA content of 11% and more. High EVA copolymer of 11% up to 16% provide improved strength and barrier performance properties to the LDPE film applications and are positioned in the industry as High Value Added LDPEs. High EVA copolymers of 18% to 22% affect the crystallinity of the polymer making them amorphous and more suitable for the adhesives and sealants applications. Beyond 22% VA content materials are used as specialty sealants.

The value addition of VA is a reactor process, thus all the value added is kept at the manufacturer level. The value added to

high EVA at the end user level has to pay for the cost of VA comonomer as well as the reduction of reactor capacity utilization costs. In addition to the expected additional profit.

High EVAs represent an excellent example of the specialty products with process and comonomer as the differentiation points.

Metallocenes, revolutionized the last decade by developing products that have improved characteristics compared to traditional Z-N catalyst based products. Metallocene and Single Site catalyst based products provided: (1) narrower molecular weight distribution, (2) better comonomer incorporation and (3) lower densities – compared to conventional Z-N based products. These characteristics provided the several advantages at the end user level including: (1) impact strength, (2) clarity, (3) organoleptic properties, (4) heat-seal characteristics and most importantly an opportunity to downgage.

Metallocenes have been looked at from two points of view: (1) a natural evolution of polyolefin technology – LDPE – LLDPE – metallocenes and (2) as new polymers that provided new opportunities, especially at lower densities and applications requiring downgaging.

If we look at metallocene as yet another step in polyolefins' evolution we have to accept that in few more years they will reach or exceed LLDPE/LDPE to become the next commodities. The only factor, at present that prevents metallocenes from becoming a commodity is the sunk research and development costs. Excluding the R&D costs, metallocenes are poised to become commodities because they, for the most part provide the same functions as LLDPEs – new and improved.

Plastomers/Elastomers are essentially extensions of traditional polyolefins into elastomeric applications via metallocene's capability to produce lower density materials are at present considered specialties poised to become differentiated commodities in the future.

Butene vs. Hexene vs. Octene Copolymers

Incorporation of low molecular weight alpha olefin into the polyethylene backbone provides the impact and clarity properties to the product independent of the process. The major limitation being, octane is harder to incorporate in non-gas phase processes because of its molecular weight limitations.

Octene copolymers have definite performance advantages in processing, but

are limited by technologies and suppliers – making them unique. The question still remains – are they specialties? Or differentiated commodities? Based on our understanding of the performance characteristics, we consider them differentiated commodities.

Metallocene PP Controlled Rheology Resins

Metallocenes provided the narrow molecular weight, impact strength and comonomer incorporation as the major advantages to polyolefins in general. Polypropylene could not effectively use these specific characteristics except in selected film and fiber applications. In fiber applications the controlled rheology advantages provided better fiber characteristics – thus providing an opportunity to differentiate the metallocene PPs.

TPOs/TPVs

Polypropylenes are crystalline and are rigid by nature. However, their ability to be blended with various thermoset rubbers including EPDM, Nitrile rubber, Butyl rubber etc., extended their utility to the high flex modulus applications via blending.

Most of the reactor processes are conducted at high capacities. However, post-reactor blending is done at much lower capacity resulting in higher cost and higher price at the end user level. The polyolefin industry recognized the role of compounders in TPOs since the early 80s and have always focused on developing in-reactor technologies to capture the value added. Reactor TPOs from various polyolefin producers including Catalloy Reactor TPOs based on Reactor Granule Technology have been successful in capturing part of the value.

Hence TPOs fall into the category of differentiated commodities vs TPVs fall intro the category of specialties.

CONCLUSIONS

The polyolefins can be classified into: (1) commodities, (2) differentiated commodities and (3) Specialties. Recognizing the product/process capabilities early on is essential for the successful positioning of developmental products and value creation.

There are several approaches that have been successful in the polyolefin industry:

1. Developing a product that is unique – e.g., Ultra High Molecular Weight PE, polydicyclopentadiene, amorphous polyalphaolefins, Hivalloys
2. Developing and improvement to the current product – e.g., Metallocenes, Reactor TPOs, Incorporating newer olefin and non-olefin based comonomers to the existing polyolefins
3. Developing Me-Too Products – e.g., Acid copolymers, Ionomers, tie layers etc.,
4. Developing Products specifically focused on replacing the incumbents e.g., ESIs, Rexflex, Catalloy, LLDPEs all targeted towards replacing PVC, SEBS and other existing products.

Without a doubt, technology plays the key role in polyolefin based specialties. In the coming issues we plan to address the detailed profitability issues for these products. We also appreciate any comment on the analysis.

Any attempts to develop new products based on raw innovations faced the uphill task due to the emphasis on stockholder value enhancement and need for revenue generation – sell! or be sold reality.

Hence the new deveopments will focus on product development to meet customer needs – making customer oriented

innovation more important than molecule oriented innovation.