OMNI TECH INTERNATIONAL, LTD.

A Survey of Recent Chemical Price Trends

The Potential Impact of Rising Petrochemical Prices on Soy Use for Industrial Applications

Prepared for the
United Soybean Board

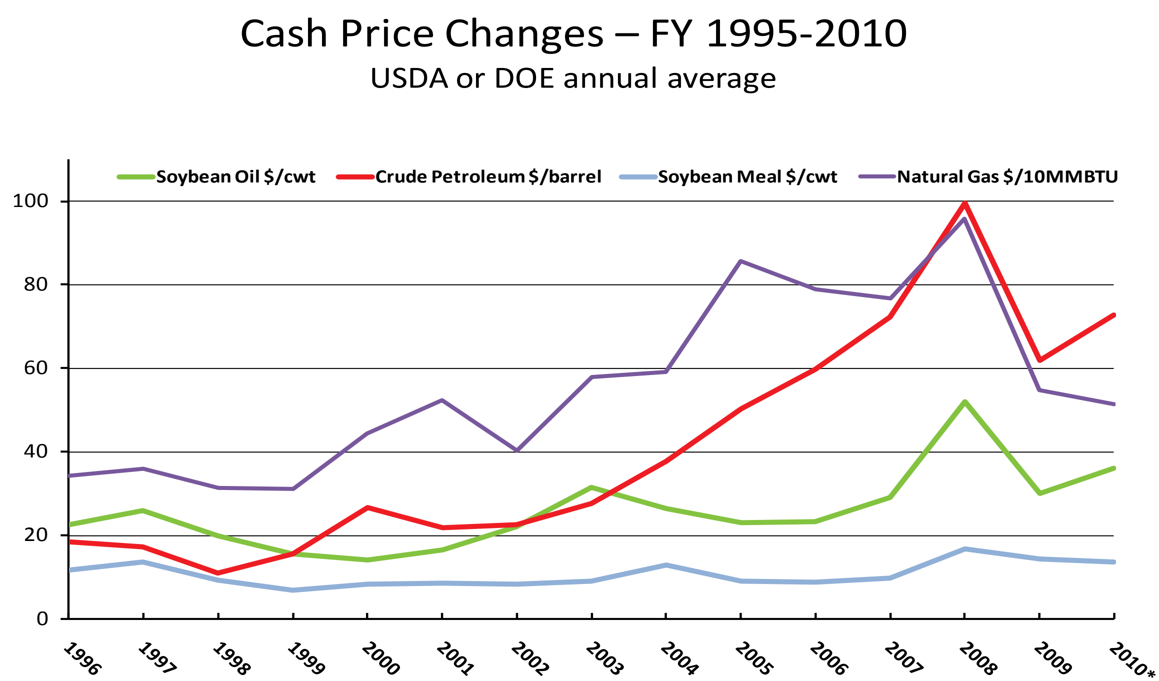
Revised 2010

CONTENTS

EXECUTIVE SUMMARY

This report details and updates for the end of 2009 specific price changes for a variety of chemicals used to make a wide range of products that either are already being made from soy derivatives or could be made from soy derivatives if affordable technology were available. It also contrasts those changes with the more stable price of soybean oil and soy protein. The price trend report was first done for the United Soybean Board (USB) in 2005, and was updated in 2008. This report for 2010 includes for the first time the implications for soy in the fiber and surfactant market areas.

The chart below tracks the price change for the last 15 years for soy oil and meal versus crude petroleum and natural gas as feedstocks for industrial chemical products. The spot price for January 29, 2010 is also provided to indicate that at any given time these commodity prices are subject to wide variations and there was more upward movement occurring at the time this report was published (April 2010).



*2010 prices are spot futures prices for near term contracts on January 29, 2010. Soy oil and meal are the March 2010 futures prices posted on the Chicago Board of Trade (CBOT), while the crude petroleum and natural gas are the February 2010 prices posted on the New York Mercantile Exchange (NYMX).

Other comments to the above chart:

- The prices for soybean oil and meal were obtained from USDA and represent the average annual price FOB Decatur, Illinois, for the marketing years ending during the year shown, except 2010.

- The prices for crude oil were obtained from the US Department of Energy/Energy Information Agency and represent the nominal cash price paid on average in the US for Light Sweet Crude for the reporting years ending during the year shown, except 2010.

- Prices for Natural Gas were obtained from the US Department of Energy/Energy Information Agency and represent the average industrial price paid in the US per million BTU for the reporting years ending during the year shown, except 2010.

- Note spot futures prices for Crude Petroleum and Natural Gas were higher in early 2009 and fell late in 2009. The spot price for Natural Gas is below the average of 2009 (October 2008 through September 2009) and has risen in recent months. Crude petroleum, natural gas and soy oil/meal prices rose to new highs in 2008 but then fell significantly in 2009. It is important to look at the current (January 2010) spot price for these commodities as only natural gas at $5.13 per million BTU and soy meal at $14.25 per cwt are showing a decrease from their 2009 levels of $5.48 per million BTU and $16.80 per cwt, respectively. Soy oil and petroleum are definitely upward in price and appear to be running in parallel, moving respectively from $0.30 per pound and $61.87 per barrel in 2009 to spot levels in January 2010 of $0.36 per pound and $73 per barrel. This does not signal an overnight transformation of the market for soybean oil or of the many industries that rely on petroleum- and natural-gas-based chemicals. Despite being the most available source of vegetable oil in North America, soy can only provide a limited portion of overall chemical needs. It does signal, however, that chemical processors and all of the downstream industries that rely upon them must recognize that soy chemistry is now more competitive economically, along with the benefits of being safer and generally better for the environment. It makes partial substitution of soy derivatives for petrochemicals a way of reducing risk and improving profits. It makes the investment in new research and development more promising. It allows a greater economic margin to incur reasonable processing costs to improve the functionality of soy chemicals while maintaining a sufficient competitive economic advantage to motivate adoption.

The following conclusions were reached in the earlier 2008 report:

- Soy oil and petroleum pricing were following similar tracks at that time.

- Soy meal had also escalated but at about one-third the increase of soy oil, thus offering new soy industrial market opportunities for meal and protein derivatives.

- Natural gas appeared to have stabilized at that time and not kept pace with petroleum and soy oil pricing, although it still was significantly above its historical price levels.

- Several products had seen significant increases – greater than soy oil – in price from 2005, such as urea, methanol and glycerin.

- Likewise, some products had incurred lower price changes compared to soy oil since 2005, such as formaldehyde and vinyl acetate.

- Economic conditions and performance attributes in many cases favored soy as an industrial product and application substitute in the existing markets that USB has been targeting. The lower relative price of soy meal offered opportunities for meal, flour and protein derivatives to compete as appropriate performance properties are demonstrated in new markets.

In the present update, there has been a significant trend: **Soy oil pricing continues to track petroleum pricing as it has done since December 2005.** Also, more complex finished goods' prices now are on the rebound from the recession of 2009.

That being said, there have been some significant strides made in soy industrial product research that now has soy competing on a functional parity or better with its petroleum-based competition.

Another key point is the soy meal price has not escalated as rapidly as soy oil and, therefore, new opportunities are being seen for soy meal or protein derivatives in adhesives, fibers (textiles), thermoplastics and other selective markets.

KEY CONCLUSIONS FROM THIS JANUARY 2010 UPDATE

- The recession of 2009 resulted in essentially a 40% drop in soy oil, crude petroleum and natural gas prices from 2008. Soy meal only dropped 16% in the same time period. Looking at the spot prices in January 2010, soy oil and petroleum have come back 17%-20%, while natural gas drops another 7% and soy meal is down 4%.
- Compared to petroleum, soy protein looks to be even more competitive today as a feedstock than in 2008 – offering potential for fermentation research and penetration into adhesive, fiber and thermoplastic markets.
- Processing costs of soy intermediates are a critical component for a viable product, as pointed out in plastics and coatings.
- Other chemical intermediates and/or end-use industrial products may be viable extensions to those compounds already being pursued, based on current soy research.
- Many of the conclusion points made for 2008 are still viable. There is no lack of availability of soy for industrial use products and applications.

SECTION 1: INTRODUCTION

1.1 THE STUDY

This study is a survey of historical prices for a wide selection of commodity chemicals and, in some cases, proprietary chemical products that are used in making industrial products in segments where soy may compete. In most cases, relevant data on supply and demand has also been collected for US and/or global consumption.

The market areas of the survey are:

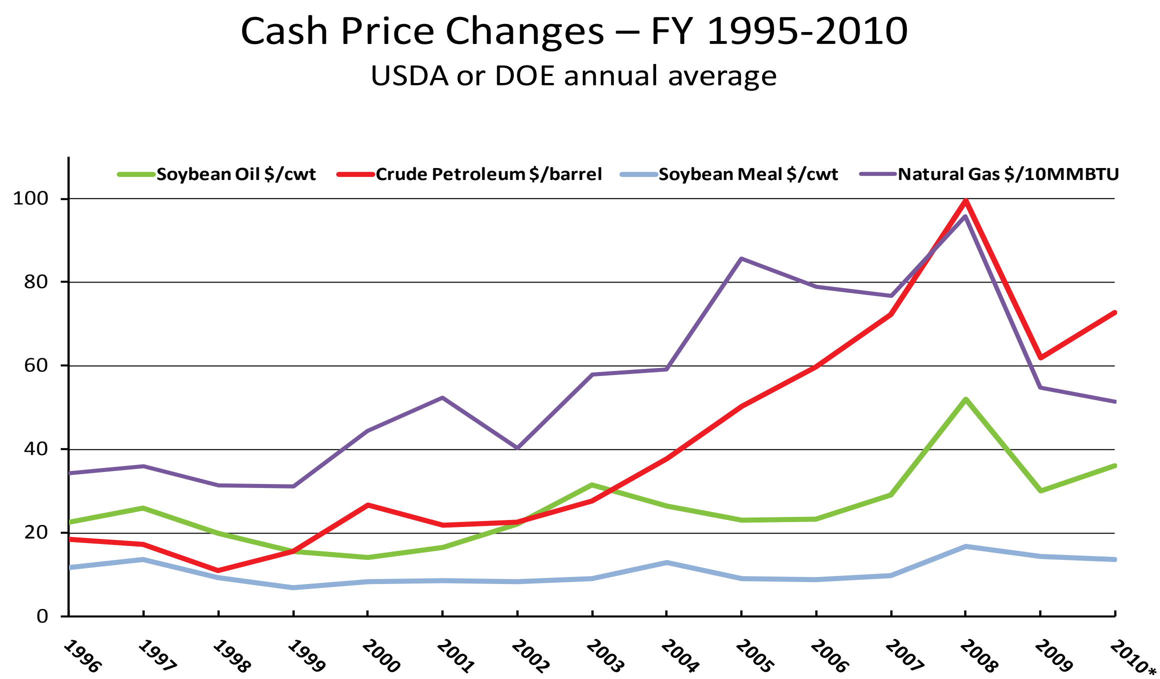
- Plastics
- Adhesives
- Coatings and Inks
- Solvents
- Lubricants
- Fibers
- Other

These segments were selected because soy is already being used or evaluated in some way for each of these markets. Research and/or commercialization efforts for new soy products are underway with funding from the New Uses Committee of the United Soybean Board. Market Opportunity Studies conducted recently for many of these market segments show that significant opportunity for market penetration by new soy products is possible if technical and economic hurdles can be overcome. These studies continue to show that industrial opportunities for soy have further improved as a result of increased research activities that have enhanced soy industrial product performance, along with improved economic potential enhanced by petrochemical feedstock price increases.

This study is not intended to quantify the market opportunity for soy in these markets, and the technical hurdles yet to be overcome are addressed only in passing. The objective is to focus attention on the changing petroleum feedstock cost relationships, which open new competitive opportunities for the development and commercial acceptance of soy-based industrial products.

1.2 UNDERLYING THESIS AND ANALYSIS

This study updates the 2008 report conducted by Omni Tech International, Ltd., for the United Soybean Board on crude petroleum and natural gas, the feedstocks from which the chemical products included in this study are made and which have changed significantly in recent years. The following chart shows the changing relationship for the key commodities: crude petroleum, natural gas, soybean oil and soybean meal.



*2010 prices are spot futures prices for near term contracts on January 29, 2010. Soy oil and meal are the March 2010 futures prices posted on the Chicago Board of Trade (CBOT), while the crude petroleum and natural gas are the February 2010 prices posted on the New York Mercantile Exchange (NYMX).

Other comments to the above chart:

- The prices for soybean oil and meal were obtained from USDA and represent the average annual price FOB Decatur, Illinois, for the marketing years ending on September 30 of the year shown, except 2010.

- The prices for crude oil were obtained from the US Department of Energy/Energy Information Agency and represent the nominal cash price paid on average in the US for Light Sweet Crude for the reporting years ending during the year shown, except 2010.

- Prices for Natural Gas were obtained from the US Department of Energy/Energy Information Agency and represent the average industrial price paid in the US per million BTU for the reporting years ending on during the year shown, except 2010.

- Note spot futures prices for Crude Petroleum and Natural Gas were higher in early 2009 and fell late in 2009. The spot price for Natural Gas in January 2010 is below the average of 2009 but has risen in recent months. Derivatives of these basic materials change as processing and packaging can greatly alter the ability for soy to compete. For example, according to outside sources, soy protein derivative prices can vary significantly as one moves downstream from soy meal that was selling as of January 2010 at $0.14 per pound:

    - Soy flour containing 50% protein was $0.18-$0.20 per pound bulk and $0.24-$0.26 per pound packaged.

- Soy basic concentrate that is alcohol washed at 69%-70% protein was \$0.65-\$0.72 per pound bulk and \$0.72-\$0.75 cents per pound packaged.
- Soy functional concentrate where solubility is required and the concentrate needs to be spray dried, which drives the price up, can range anywhere from \$0.85 per pound to \$1.25 per pound.
- Soy protein isolate containing 90+% protein and depending on the functionality required can range from \$1.50 to \$2.25 per pound.

The prices for petroleum and natural gas increased much more rapidly than soybean oil between 2003 and 2005, making soybean oil a more attractive feedstock economically than in prior years. Since the December 2005 report, the price of soy oil has basically been tracking with petroleum. The earlier price increases for petroleum and natural gas stimulated industry interest and broader research on soy oil that is resulting in even greater viability for soy oil as a substitute for fossil feedstock in many applications.

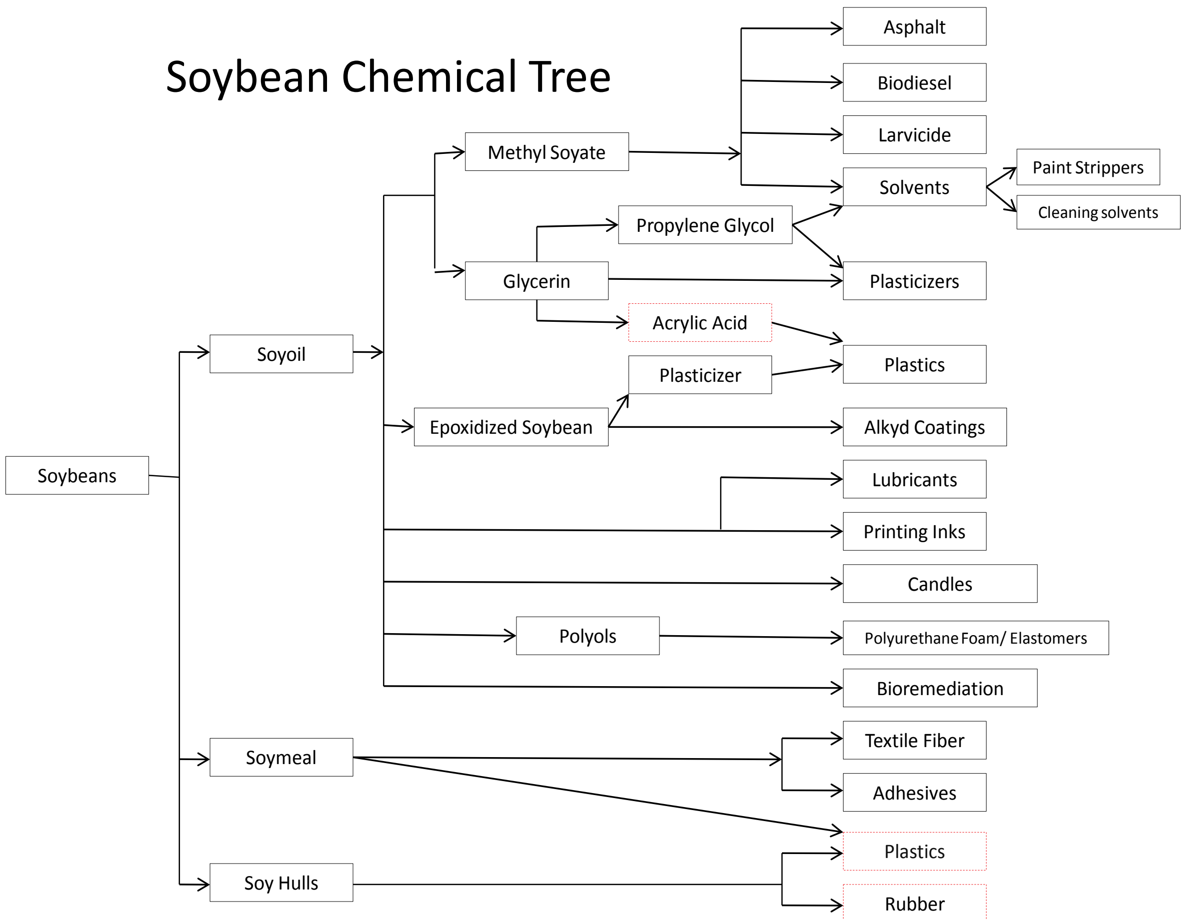
The added demand for soybean oil to make biodiesel and many new soy industrial products has resulted in soy oil becoming more of the driver of production levels over soy meal/protein (an event that happens only about once every 10 years). This has resulted in soy meal being less volatile than soy oil in price variance, although the advent of ethanol, derived from corn and being used as a petroleum substitute, has increased the demand for soy meal as an animal feed substitute for corn. One would expect that with increased soy crushing, soy meal price would drop significantly, offering opportunity for soy meal/protein industrial use.

The primary thesis, therefore, was that petrochemical products made from oil and gas and, ultimately, the end products sold in the target segments would at some point have to begin reflecting rising raw material costs.

Since market prices reflect much more than raw material costs, it was not always expected that the prices of intermediate chemicals or finished products would rise and fall in line with their underlying feedstock prices. The further a product is removed from the underlying feedstock and the more costs involved to be recovered by the final product sale, the longer the lag time will be in capturing the raw material cost escalations and the less the impact of the raw material price change will show in the ultimate market price.

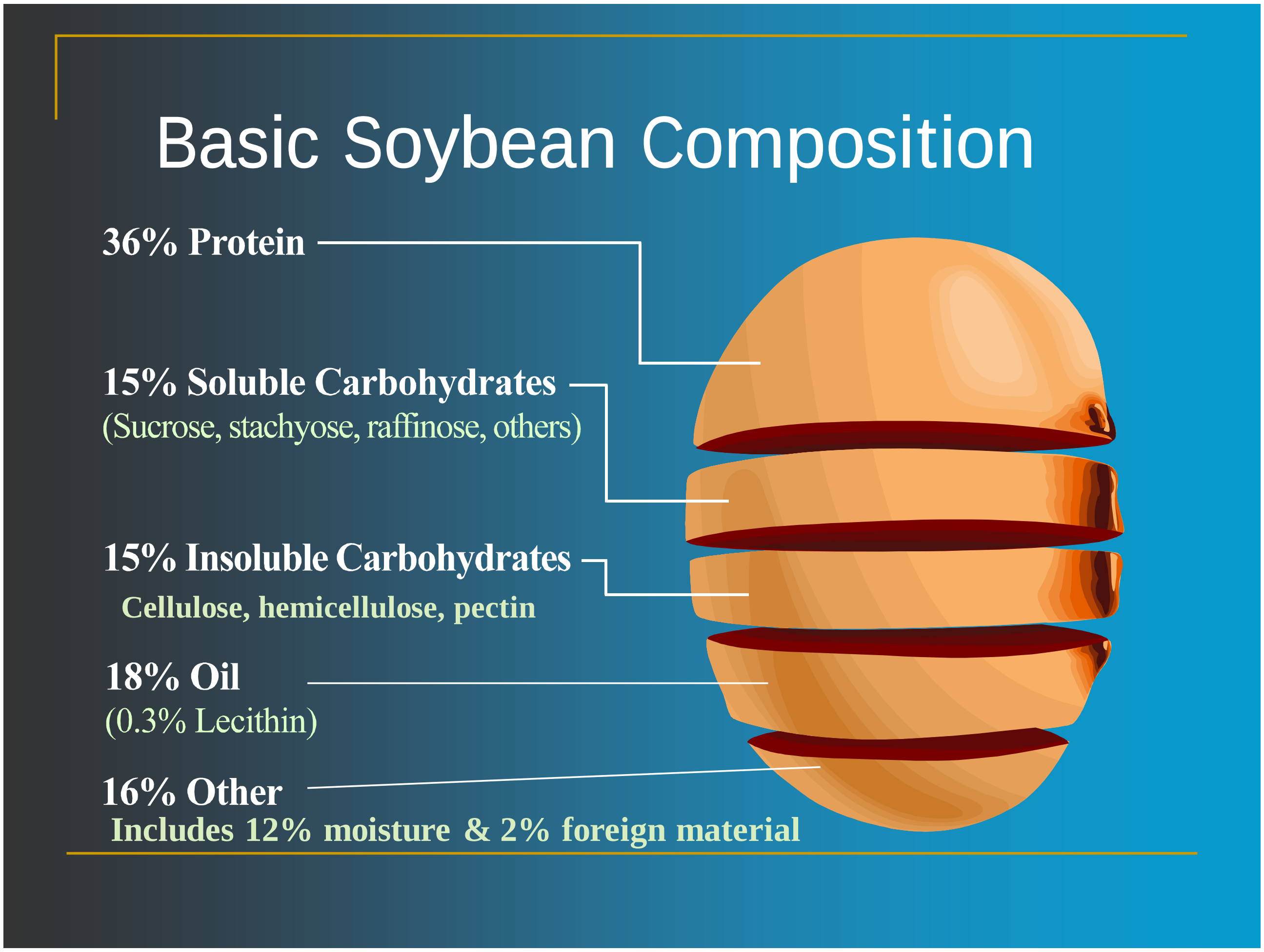
1.3 THE RELATIONSHIP TO SOY

Soy oil and protein can compete with many petrochemical feedstocks in a variety of end use markets. The soy chemical tree chart below provides a schematic as to some of the markets where soy oil and/or protein and their derivatives might complement or substitute for petrochemical feedstocks.



While it might be convenient to say that soybean oil is competitive in price as a feedstock when the price per barrel for crude petroleum or price per million BTU for natural gas exceeds some point, no such exact relationship exists for all markets or even for similar applications within one market. For instance, the substitution of soy polyols in the formulation for making polyurethane carpet backing allowed cost-competitive foam to be developed. Soy polyols used for this application are still cost effective today with petrochemical derived polyols. However, in other high performance applications, soy polyols do not yet provide the cost/performance advantage necessary to be viable substitutes for traditional petroleum- or natural gas-based polyols.

Soybeans are comprised of an average composition as shown on the next page. There can be significant variations among soybean varieties and regions due to growing conditions. Primarily, soybeans are grown for two components: oil and protein. When the oil is removed, either by expelling or solvent extraction, the remainder is principally soybean meal, which is valued for its high protein content as animal feed. Note that oil is 18% of the soybean by weight, or about 11 pounds of oil from a 60-pound bushel of soybeans. If one were to crush all the soybeans produced in the US annually, which is about 3.2 billion bushels, there would be more than 35 billion pounds of oil per year. As about 40% of the crop is exported as whole beans, the actual soybean crush represents more than 20 billion pounds of soy oil per year.



1.4 OTHER COMPETING OILS

The analysis of the impact of rising petroleum and natural gas prices on soybean oil is not complete without some view of other competing vegetable oils and animal fats. Like soy, prices of most of the natural oils have not kept pace with the petroleum feedstocks. In some cases, demand for these oils as petrochemical substitutes will increase. Palm oil, canola (or rapeseed) and animal fats will undoubtedly be used along with soy in biodiesel. Canola should also see greater use in lubricant and some polyurethane applications. Linseed oil may regain lost market share in some coatings applications.

In general, however, the larger volume oils such as palm oil or animal fat are not suitable for many of the applications detailed in this report, such as plastic or coatings applications, due to their high level of saturated fats. Others like canola or linseed are not available in sufficient quantities in North America to win broad use in these applications.

What can be said at the start of 2010 is that:

- Chemically modified soy oil and meal derivatives demonstrate strong cost/performance competitiveness in many market applications.
- Since 2005, soy oil pricing has tended to follow petroleum pricing after gaining significant economic benefits for soy oil over petroleum between 2003 and 2005.
- Soy meal from the period of 1996 thru 2009 has shown less price increase and has been less variable in price than soy oil, petroleum and even natural gas, offering the opportunity for increased industrial product usage should performance warrant.
- Relative increases in natural gas and petroleum pricing will continue to lead to increased use of soy materials in markets where performance issues have been sufficiently addressed. No other vegetable oils have the combination of suitable fatty acid profile and broad availability to take full advantage of the economic opportunity now presented.
- In those markets where performance and/or processing costs are still an issue, the competitive motivation for seeking improved performance of soy products while still remaining economically competitive is significantly increased.

SECTION 2: PLASTICS

2.0 OVERVIEW

Plastics are an omnipresent part of everyday life in the world. They are present in or part of an astounding array of products from disposable utensils to medical devices. They are used to replace wood, metal, glass, natural fibers and even stone or concrete. While some of the earliest forms of synthetic plastic materials were developed from natural products such as celluloid from cotton and later wood cellulose, all of the large volume plastics produced today share the fact that they are derived primarily from petroleum or natural gas, although modern bioplastics based on soybeans, corn and other biomass are beginning to make commercially significant inroads.

This section quantifies how the rise in petroleum and natural gas prices, the basic raw materials for plastics, has impacted the price of the basic chemicals and intermediates used in making plastics. Since the September 2008 report, the global plastics industry has seen a drop in demand in 2009 due to the global economic contraction. Coincidentally, petrochemical raw materials have also experienced a drop in demand and price from the highs reached in 2008. Recently (2010) the demand for plastics has begun to recover, which in turn has resulted in increased prices for the petrochemical building blocks of ethylene, propylene and benzene.

The trend of “plastic resin production migration” to other global locations, most notably the Middle East, where petroleum and natural gas are more readily available and economical, continued through the 2008-2009 global economic contraction. A comparison of soybean oil prices to petroleum and natural gas prices provides a reference to show that soy oil and meal have become more economically attractive as a feedstock for plastic production. This does not mean soy derivatives could or should be used in all plastic applications. One of the key areas for soy oil polyol growth is polyurethane markets known as CASE (coatings, adhesives, sealants, elastomers). The focus of this plastics report is on segments where use of soy oil or protein has been shown to be technically feasible or where preliminary research indicates that processes could be developed to allow soy oil to be economically competitive, such as thermoset plastics. Another area based on economic potential that bears consideration for future research is the large thermoplastic market.

The following key plastic markets are addressed in this report:

- Propylene - a basic petrochemical building block for plastics
- Polyols for polyurethanes - thermoset plastics
- Unsaturated polyester resins for composites - thermoset plastics
- Thermoplastics - plastics that can be reshaped by heating

2.1 PROPYLENE

Propylene, a three carbon molecule with the formula $H_2C=CH-CH_3$, is a basic petrochemical building block used in the production of the very large volume thermoplastic polypropylene, and in the production of large volume basic oxygenated chemicals, such as acrylonitrile, propylene oxide, oxo-alcohols, acrylic acid and isopropanol.

Useful chemical derivatives of this molecule can be produced from the hydrolysis and oxidation of soybean oil or the fermentation of starch or corn syrup. Chemical intermediates produced include glycerin, 1, 3-propanediol, acetol and lactic acid. These intermediates after further processing will yield additional chemicals and plastics. As demand and prices for oxygenated propylene derivatives increase in the future, driven by increases in oil and natural gas, these oxygenated hydrocarbon derivatives from bio-refineries will become a key cost-effective alternate source for oxygenated propylene intermediates. Many of these intermediates are used to form the backbone of a variety of plastic polymers.

Supply and Demand

North American historical annual demand growth for propylene is reported by several published industry sources to have been between 4%-5%. This rate was reduced in 2009 as a result of the global economic slowdown. According to published estimates, the 2009 demand for propylene decreased approximately 10% from 2008. In North America, propylene is produced as a by-product of petroleum refining and as a co-product from liquefied petroleum gas (LPG).

The North American chemical industry's propylene supply is very dependent on steam cracking naphtha from oil refineries or liquefied petroleum gas, sourced from natural gas liquids. Steam crackers also produce ethylene as a co-product in greater quantities. Industry sources estimate that liquefied-petroleum-gas-based ethylene plants operated in excess of 90% of nameplate capacity and used high levels of ethane as fresh feed in order to maximize production of ethylene. This operating strategy optimized ethylene production but held propylene production down. However, the outlook for 2010 is for propylene demand to increase its growth rate over ethylene; thus more will have to be produced from multi-feed refinery cracking units or from dedicated propylene production units utilizing more complex processes, such as deep catalytic cracking, propane dehydrogenation (PDH), metathesis chemistry, or methanol to olefins (MTO) that are being developed to increase supply, all of which come with higher capital costs to the industry.

Propylene Usage

	2008[1]	2003[2]
Polypropylene	54%	50%
Propylene oxide	12%	10%
Cumene	8%	8%
Oxo-alcohols	4%	7%
Acrylic acid & esters	4%	5%
Oligomers	-	4%
Isopropanol	4%	3%
Ethylene propylene elastomers	3%	3%
Miscellaneous	2%	-

[1]Omni Tech Estimate
[2]Chemical Marketing Reporter, October 2003

Price Trends

Since the last report in September 2008, global demand for propylene shrunk significantly in the fourth quarter of 2008 and first quarter of 2009, causing year-over-year comparisons to be lower in 2008 versus 2007, and 2009 versus 2008. In 2008, the contract price of propylene in the US increased from $0.62 per pound to a high of $0.85 per pound in August in response to the sharp increases in oil and natural gas prices.

However, since June 2008, price highs in crude oil and natural gas fell from $143 per barrel to $35 and from $13.50 per million BTU to $6.35, respectively, and the contract price of polymer grade propylene fell to $0.20 per pound.

	2006	2007	2008	2009
Polymer-Grade Propylene Contract (cents per pound, year end)	**41***	**62***	**21***	**54***
Yr. Avg. Natural Gas ($ per million BTU)	7.09	6.82	9.58	5.84
Yr. Avg. Crude Oil ($ per barrel)	66.1	72.2	99.57	61.87
Soybean Oil (cents per pound)	**23**	**31**	**52**	**30**

*Various sources

Propylene is also widely used as a feedstock for octane improvement in gasoline; therefore, propylene's status as a basic petrochemical building block for plastics, oxygenated chemical intermediates and gasoline make it a critical raw material for our economy today and in the future. The previous table reports full year average numbers for 2009. During the first month of 2010, crude oil prices have ranged between $70-$80 per barrel, while natural gas prices have ranged between $4-$6 per million BTUs.

2.2 POLYOLS FOR POLYURETHANES

The major intermediate chemicals or raw material building blocks (propylene oxide and ethylene oxide) are used to produce polyurethane polyols. Any change in the cost of these basic raw materials flows directly through the production chain to final polyurethane products. As the cost of energy to run petrochemical production plants increases, the cost to manufacture polyurethane products derived from petroleum products also increases.

PROPYLENE OXIDE

Pricing

Historically, the actual selling price for propylene oxide (PO) has been generally stable with small consumers paying published or list selling prices. Since published prices of propylene oxide are not correlated with published polyol pricing, it is believed a better raw material cost correlation with polyol prices is the published price of propylene, which is the major raw material cost input to propylene oxide along with energy costs to produce oxide, all of which are passed directly to the polyol manufacturer’s plant as raw material costs.

Implications for Soybean Oil

Even though propylene oxide is a primary raw material for polyurethane polyols, the key cost driver impacting petroleum-based polyols, according to a urethane supplier spokesperson, is propylene. The decline in the global economy starting in 2008 and continuing in 2009 negatively impacted the demand for propylene until the fourth quarter of 2009, and consequently the demand for propylene oxide and polyols; thus causing PO-containing polyols to be more cost competitive than they were in 2007 and for three quarters of 2008. <u>The use of soy oil as a starting raw material for production of polyols eliminates the need for propylene oxide, thus saving considerable energy costs.</u>

Polyurethane Uses

Polyurethanes are thermoset polymers, differing from thermoplastic polymers in that they are not able to be reformed through reheating. They find broad use in a wide variety of applications, ranging from flexible foams for bedding to high-density, closed-cell decorative wood replacement. Polyurethane products are used to make vehicle parts, seats and coatings for the transportation industry; insulation, sealants and coatings for the construction industry; flexible foams for the furniture, bedding and carpet industries; elastomers for a multitude of industrial and mechanical applications; flexible tubing and medical devices; and a large variety of industrial adhesives. Appliances that require insulation also use polyurethane closed-cell rigid foam.

This broad use profile is a result of the large variety of chemical compounds that can be incorporated into the reaction that forms the polyurethane polymer. Polyurethanes are thermoset polymers based on the reaction of two chemicals: an isocyanate and an active hydrogen-containing compound. The most widely used active hydrogen-containing compounds in polyurethane production are polyhydroxy alcohols, commonly called polyols. Polyols, designated the "B" side of a two-part reactant mixture, normally make up 40%-60% of the weight of an unfilled polyurethane polymer, depending on the density of the foam or elastomer being made. The "A" side (isocyanate) is a petroleum-derived monomer.

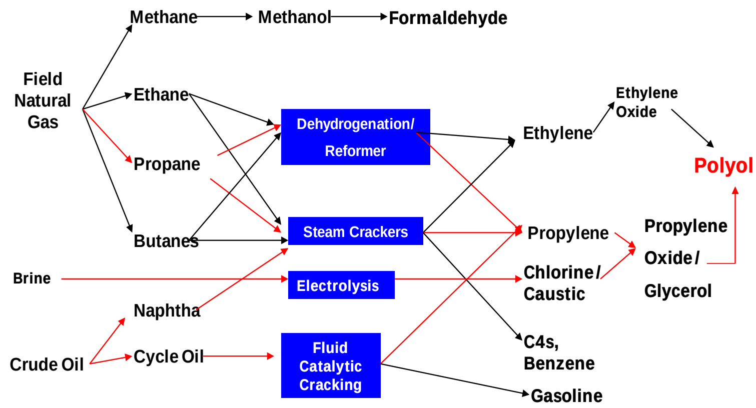
Supply and Demand

Polyols can be made from a variety of starting raw materials that are either hydrocarbon or biomaterial based. However, hydrocarbon-based polyols are utilized in far greater quantities than are biobased polyols at present. The largest volume hydrocarbon-based polyol product is made from glycerin and oxides of propylene and ethylene. Propylene and ethylene are petrochemical monomers that are derived from natural gas liquids or petroleum. These monomers are reacted (oxidized) to make propylene oxide and ethylene oxide. They are then further reacted with a chemical "initiator" (low molecular weight polyhydroxy alcohol), such as glycerin or sucrose, to produce a higher molecular weight, hydroxyl-containing polyol.

North American (NAFTA) demand by the polyurethane industry for all types of polyols was estimated at 2.4 billion pounds in 2009 by Omni Tech International, a decrease of 16% from 2008 demand, which was down 6.7% versus 2007. North American demand represents about one-third of the global polyol market.

Basic Processes to Produce Polyols
The accompanying chart illustrates the basic processes employed to produce a polyol from natural gas or crude petroleum for use in polyurethane applications.

Brine, Natural Gas, Crude Oil to Propylene Oxide



Price Trends
As mentioned earlier, the basic raw materials used in the production of polyurethanes are derived from oil and natural gas (propylene oxide, ethylene oxide, glycerin). A Dow Chemical polyurethane spokesman estimated that for every $0.10 per pound increase in the price of propylene, there is a $0.07-$0.08 per pound increase in the manufacturing cost of polyols. The prices of the petrochemical derivatives were generally increasing through most of the time period January 2006 - September 2008. At the start of 2007, base polyol prices were estimated at $1.10 per pound for flexible slabstock polyols and $1.16 per pound for rigid polyols.

Polyol Raw Materials/Polyols	2005 Year End	2006 Year End	2007 Year End	2008 (August)	2008 Year End	2009 Year End
Flexible polyols (cents per pound)	110*	110*	117*	130*	105	95
Rigid polyols (cents per pound)	123*	116*	123*	145*	112	105
Propylene (cents per pound)	51*	41*	62*	85*	20	54
Light sweet crude oil ($ per barrel)	52	64*	100*	120	42	75
Soybean oil (cents per pound)	23	23	31	51	29	36

*Various sources

In early 2007, significant increases in hydrocarbons, particularly oil derivatives, started to occur. But the polyol manufacturers were reluctant to raise prices and risk losing market share until the last quarter of 2007. Finally, the relentless increase in hydrocarbon prices, especially propylene, forced the polyol manufacturers to announce a series of dramatic increases in October 2007. These increases set the stage for further increases in polyol pricing in 2008 as petrochemical raw materials continued to rise as a consequence of the price increases in oil and natural gas. These raw material increases stopped as economic activity stalled in August 2008. Demand for polyols dropped dramatically. Following the drop in demand for polyols, prices fell to $1.05 per pound for flexible polyols and $1.12 per pound for rigid polyols by the end of December 2008.

Demand for plastics continued to drop in 2009 as hydrocarbon prices also dropped during the first three quarters of 2009. Based on discussions with polyol consumers in several different market segments, it is estimated that for all of 2009 the demand for polyols was down between

16%-18%, with a commensurate drop in polyol prices to $0.95 per pound for flexible polyols and $1.05 for rigid polyols.

Implications for Soybean Oil

The opportunity to provide a partial replacement for hydrocarbon polyols has been recognized by several companies. Urethane Soy Systems, BioBased Technologies, Dow Chemical, Cargill, and MCPU Polymer Engineering have soy-based polyols for commercial sale. Each company has developed different production processes, resulting in a variety of polyols to fit different applications. Interest by converters in formulating polyurethanes with these products is high because of continued interest in utilizing renewable biomass-derived polymer feedstocks and the future pricing outlook for oil- and natural-gas-derived raw materials. Additional development work continues to improve the processes used to make soy polyols and to improve the properties of these biobased polymer intermediates, as well as increasing the soy polyol concentration in the polymer formulations.

If the economics for production of soy polyols remain competitive and performance properties are found to be equivalent or better than their petro-based counterparts, it is projected that the use of soy-oil-derived polyols in North America could increase during the next five years to 620 million pounds. This would equate to oil from 56 million bushels of soybeans.

Soy polyols offer a polyurethane producer not only an opportunity to diversify their product line, but to also develop a more sustainable raw material source, which has a positive impact on the environment when compared to petroleum-based urethane chemicals. It is significant to note that palm oil, due to its high level of saturates, cannot compete with soy oil as a starting raw material for production of polyol, and any modification to reduce the level of saturates would likely put palm at a large economic disadvantage to soy.

Soy oil pricing did tend to parallel petroleum feedstock pricing until 2009. Due to an exceptionally large harvest, soy oil prices have remained constant while propylene, the main petroleum-based polyol feedstock, has increased by $0.15 per pound or 36% since November. Currently, polyols derived from soy oil are estimated to be competitive with petroleum-derived polyols.

CHANGES SINCE 2008

Soy polyols have become an established urethane chemical for the production of polyurethanes. Technical developments by producers have continued to improve the property profile of the polyols and allowed their use in a broadening array of applications. Petroleum-based polyether polyols continue to be driven by increases in the petroleum hydrocarbons from which they are derived.

2.3 POLYESTER RESINS

Polyester resins are used in a wide variety of applications ranging from extremely flexible materials, such as synthetic fibers, to rigid materials, such as auto body parts, bathroom, kitchen and laundry units and polymer concrete. The major targeted use for soy replacement has been in reinforced composites, such as those used by Deere & Company for exterior panels in the manufacturing of combines.

The resins used in composites are primarily made from a condensation reaction of maleic anhydride, other acids and various glycols, such as propylene glycol. This material is made under significant heat, vacuum and pressure and produces a fairly crystalline material that is solid at room temperature. Before packaging, the solid resin is dissolved in styrene monomer to make a flowable liquid for molding with reinforcing materials, such as fiberglass and other fillers. With a choice of different additive materials, components and recipes, the molder can utilize the polyester resin formulations to fabricate a wide range of commercial products.

Unsaturated polyester resins are thermoset resins used in composites that are made from maleic anhydride, saturated acids, glycols, and monomers. Polyester resins are thermoplastic resins used in fibers or drinking containers and are made from saturated acids and glycols. Maleic anhydride, saturated acids, glycols and monomers are all derived from crude oil during refining or from the cracking of natural gas liquids.

Supply and Demand

US demand for unsaturated polyester resins grew at a 4% annual rate during the economic boom of the late 1990s before falling in late 2000 with the recession of 2000-2001. In 2004, US market demand was estimated to have recovered above the level of 2001, and in 2005 had peaked to a total of 1.9 billion pounds of resin. With the current downturn in the market, the annual usage in 2009 was about 1.0 billion pounds, which is the largest percentage drop of any recession in the last 50 years.

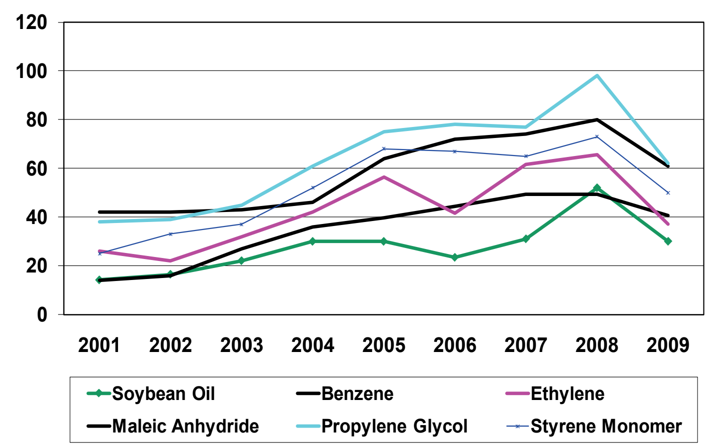
Intermediate Chemical Pricing

Maleic anhydride, propylene glycol and styrene monomer pricing is reflecting the rising cost of crude petroleum and natural gas, though chemical industry pricing is driven by numerous factors. Weak demand in the recessionary period of 2001-2002 held prices of the three chemicals down despite some increase in raw material prices until production declines brought production back in line with demand in 2003. Starting in January 2004 and through the end of 2006, prices of these intermediate chemicals had doubled. With the decline of crude oil prices and the last recession, prices have fallen. However, pricing of all materials are starting to increase again in 2010.

The graph on this page displays the petrochemical-based polyester intermediate price changes in the past nine years compared to soy oil.

Polyester Intermediate Prices

2001 – 2009 Cents per Pound



Polyester Resin Pricing

Faced with rising prices for chemical intermediates and with the energy required to make them, the makers of polyester resins have pushed price increases through the system as quickly as possible. Because of the economy in the 2001-2002 timeframe, resin producers lost profit margin. As the price of raw materials increased, resin price increases were adjusted to recapture lost profit margin. These price increases averaged about 20% each year from 2004 through the end of 2006.

The economy slowed in the 2007 and 2008 time period and price increases were held back in the face of rising material costs to gain or retain market share at the expense of profitability. With raw material prices increasing and the economy improving, prices are on the rise again.

The following table indicates the reported prices of one of many categories of resins:

UNSATURATED POLYESTER RESINS	
Year	GP Ortho Average Reported Price (cents per pound)
2001	53
2002	48
2003	54
2004	69
2005	93
2006	100
2007	99
2008	106
2009	89

Implications for Soybean Oil and/or Soybean Meal

Ashland, Inc., has pioneered a process for making unsaturated polyester resins used in composites where a combination of soybean oil and ethanol derived from corn is substituted for a portion of the acids and glycols found in conventional unsaturated polyester resins. In a life cycle study of the resulting process, considering both process energy usage and the partial replacement of petroleum-derived feedstocks, there is a reported substantial savings in total petroleum required.

While soybean oil cost has remained below other glycols, such as propylene glycol, the usage of soybean oil in polyester resins was initially confined to one company: Ashland. However, as raw material prices increase relative to soybean oil, other unsaturated polyester resin producers, such as Reichhold, Inc., have introduced in 2009 a biobased resin partially made from soybean oil.

Of the six major producers, four have announced that they are producing rapidly renewable resins derived from biobased sources (crops). In addition to Ashland and Reichhold, Interplastic Corporation and AOC, LLC, have recently announced resins made from biobased sources.

A number of companies have announced initiatives to produce at least four chemicals used in unsaturated polyester resins from biobased sources. These chemicals include fumaric acid from sucrose fermentation, propylene glycol from dehydrogenation of biodiesel glycerin, terephthalic acid via oxidation processes using biobased sources, and ethylene glycol via oxidation processes using sucrose sources. Depending on the technology and cost assessment, a replacement for maleic anhydride using fumaric acid fermented from soybean oil and/or meal could be realized. The economics of biobased materials versus petroleum-based materials and optimization of processes to make these chemicals will all determine the timing to market.

POLYESTER RESIN - INTERMEDIATE CHEMICALS

Maleic anhydride, propylene glycol and styrene monomers reflect the rising prices for crude oil and natural gas, though chemical industry prices are sensitive to many factors including demand. Weak demand during the recessionary period in 2001 and 2002 held prices of the three chemicals flat despite some rise in raw material costs until production declines brought supply back in line with demand in 2003. In 2004 and through 2008, prices for the materials had increased significantly. With the decrease of crude oil prices in late 2008 and the economic recession, prices decreased again. However, prices are increasing again with increasing crude oil prices and intermediate product demand in 2009 and 2010.

MALEIC ANHYDRIDE

Maleic anhydride is a highly versatile chemical intermediate essential to the production of a multitude of products. Its largest single application is in unsaturated polyester resins used in construction, transportation and marine industries. Maleic anhydride is also used in motor oil additives, artificial sweeteners, flavor enhancers, paper sizing, water treatment chemicals, epoxy curing agents, hair sprays, pharmaceuticals, agricultural chemicals and co-polymers. Maleic anhydride is undergoing renewed interest due to development of process technology to convert this chemical to butanediol and tetrahydrofuran.

In North America, Marathon, Bayer Lanxess, BP Flint Hills, Bartek and Huntsman produce maleic anhydride. Bayer, BASF, Lonza and DSM Chemicals manufacture the product in Europe. Maleic anhydride is a regionally produced material due to the physical nature of the product (a solid at room temperature, but typically processed in the molten state), but is moving to a global commodity with an increasingly significant portion of the world's production and trading being done by companies from the Asian rim, especially China and India.

In the US, the product is made from n-butane, which is passed through a catalyst in a fixed bed reactor. N-butane is typically derived from the oil refining process or extracted from natural gas liquids. All North American plants have been converted from using benzene, which is derived from the first cut of crude oil, naphtha. Reforming naphtha yields the "BTX stream:" benzene, toluene and xylene. Benzene is converted into maleic anhydride via catalytic vapor phase oxidation. Some benzene continues to be used in Europe and even more so in Asia. Both processes are sensitive to the cost of energy as well as raw materials.

Supply and Demand

The estimated maleic anhydride demand in North America in 2008 was more than 560 million pounds. Polyester resins represent about 63% of the total demand, followed by additives for lubricants at about 12%, and butanediol-related chemicals at 6%. The rest of the volume is dispersed throughout a number of smaller markets.

Growth of maleic anhydride use increased at an annual rate of more than 3.5% through most of the 1990s before the economic recession in 2001-2003 dropped growth to less than 1% annually, primarily due to weak demand for polyester composites. From the time period of 2001-2006, growth in demand averaged 2.8% per annum. Potential demand for use in reinforced composites for automotive uses could expand at a more rapid rate as lower weight parts help to support increased fuel economy. To achieve greater use in making exterior parts for automobiles, improvements in the paintability of finished exterior parts needs to be recognized by the auto manufacturers. Many parts made for non-show surfaces, such as valve covers, are in use for a variety of vehicles.

Pricing (see chart on page 16)

The selling price for maleic anhydride had been generally stable through the late 1990s and early part of this century. In 2004 with demand for polyester resins growing and the cost of butane rising, global prices jumped by 39% from $0.46 per pound to a high of $0.64 per pound. Prices continued to rise in 2008 with prices reported as high as $0.85 per pound in July 2008. Prices decreased to about $0.60 per pound in 2009, but have increased upward to more than $0.70 per pound with increasing feedstock prices.

Implications for Soybean Oil and/or Soybean Meal

An improved understanding of the effect of modifying enzymes for fermentation could lead to the production of fumaric acid, which is an isomer of maleic anhydride (acid). This fumaric acid could be used in place of maleic anhydride and/or converted to maleic anhydride. While sucrose from corn or other crops is used for biobased materials, the carbohydrates in soybeans are a potential source for these chemicals.

PROPYLENE GLYCOL

Propylene glycol is a widely used chemical both in formulated products and as an intermediate in the production of a number of types of plastic products. In North America, Arch Chemical, Dow Chemical, Huntsman and Lyondell are major producers with annual US capacity estimated at 1.59 billion pounds. The US has typically exported up to 27% or more of domestic propylene glycol production.

The product is made through a liquid phase hydration of propylene oxide. Water and propylene oxide, derived from propylene, are reacted at up to 200° C, forming mono-, di- and tri-propylene glycols, which are separated from water through distillation. The process is sensitive to both the cost of raw materials (propylene from natural gas) and energy costs.

Supply and Demand

Demand for propylene glycol in North America was estimated in 2008 at 1.0 billion pounds annually. Of that, 26%-27% is utilized in the manufacture of unsaturated polyester resins and about 22% is used in de-icing fluid, engine coolants and industrial heat-transfer fluids. Liquid detergents account for another 15% of demand. Propylene glycol is also available in pharmaceutical or food grades. Food, cosmetic and pharmaceutical use accounts for approximately 20% of the market. The balance is used in a wide number of smaller applications, including paints and coatings.

Propylene glycol demand increased at an annual rate of more than 4.4% through the 1990s before the economic recession in 2001-2002 caused an overall decline, primarily due to weak demand for polyester composites. Since late 2003, demand for use in polyester resins has been strong due to increased demand for downstream products. Demand growth is estimated to have returned to a level of 2% or more per year in many applications before the latest economic recession. Use in food and pharmaceutical applications has been less robust due to competition from low-cost glycerin derived from biodiesel. Potential demand for use in reinforced composites for automotive uses could expand at a more rapid rate as lower weight parts enhance increased fuel economy.

Pricing (see chart on page 16)

The selling price for propylene glycol has been extremely volatile, reflecting swings in demand, supply and cost. The rising costs of raw materials and energy used in reforming propane into propylene and then into propylene glycol squeezed the profitability from manufacturing during 2001, leading to a withdrawal from the market by Eastman Chemical. As supplies have tightened due to production reductions and demand rose with the improving economy, spot prices increased by 156% since 2001. Most polyester resin manufacturers enjoy some price advantage over spot prices and negotiated contract prices. Prices peaked in late 2008 and early 2009, bottomed in the fall of 2009 and are on the rise again in late 2009 and early 2010.

Implications for Soybean Oil

Alternative methods for producing propylene glycol (PG) from glycerin have been developed by various organizations. Glycerin is a co-product from biodiesel production using soybean oil and can be used in a traditional chemical conversion to produce propylene glycol. Archer Daniels Midland (ADM) is reported to be starting up a plant in Decatur, Illinois, in 2010, using glycerin and sorbitol as raw materials. Huntsman and Dow Chemical have also announced plans to make propylene glycol from glycerin. Metabolic Explorer in France has announced a bioprocess technology to produce propylene glycol from glycerin. With an abundance of crude glycerin from biodiesel plants, the economics for these new plants and processes are attractive. However, new uses for crude glycerin have been found, which have driven up its cost and slowed the building of plants with this newer technology.

STYRENE MONOMER

Styrene monomer is a basic commodity chemical used in a wide range of plastic applications. Polystyrene is widely used in making rigid insulation foams, sometimes referred to generically as Styrofoam™, which is a trademark of the Dow Chemical Company, and expanded polystyrene beads used in disposable cups. Styrene monomer can be combined with unsaturated polyester resins to make fiberglass reinforced composites, with butadiene to make synthetic latex rubber materials for tires and carpet backing, and with acrylonitrile and butadiene to make thermoplastic resins, such as ABS plastic.

Styrene monomer is typically made through a reaction of benzene and ethylene. Benzene may be derived from many hydrocarbon sources, but most of the world's supply has been made from naphtha, a product of crude oil refining. Ethylene may also be produced from a variety of fossil hydrocarbons, though most is obtained from natural gas separation. The rapid rise in prices for these two raw materials (see chart on page 16) has had a significant impact on styrene monomers and all downstream styrene derivatives.

Supply and Demand

US production capacity for styrene monomer was estimated at 13.7 billion pounds annually in 2008. Of that, 65% is utilized in the manufacture of polystyrenes, while only 6% is used with unsaturated polyester resins for composites and other applications. Major manufacturers are Dow/Chevron Phillips, Cos-Mar (owned by Total/GE), Dow Chemical, Lyondell, Inoes Nova, Sterling Chemicals and Westlake Chemicals.

US demand for styrene monomer in 2008 is more than 9 billion pounds, with exports exceeding imports by approximately 3.1 billion pounds. The total global market has experienced a decrease due to the economic downturn.

Pricing (see chart on page 16)

Pricing of styrene monomers responds to many factors. Supply disruptions, currency fluctuations and economic expansions or recessions in any of the producing or importing countries may cause world prices to rise or fall by several percent.

During the1990s styrene monomer prices were generally between $0.30 and $0.40 per pound, escalating slowly driven by the demand from the robust economies in the US and most of Europe. They peaked at $0.45 per pound in 1995 due to supply disruptions before falling back below $0.40 per pound in 2000.

Styrene monomer prices eroded rapidly in 2001 when economic recession in the US and elsewhere weakened demand. Prices fell below $0.30 per pound for brief periods in the post 9/11 doldrums of 2002 until significant plant capacity was idled by major producers to tighten supply. In late 2002 and throughout 2003-2004, prices began a steady and at times dramatic rise in response to escalating raw material prices, especially for benzene. At the same time world demand has increased, especially in China, causing production to rise and market supplies to tighten. Estimates of styrene monomer contract prices for 2004 showed a then historical high of $0.68 per pound, about double the historical range and 250% above the lows seen as recently as 2002. Styrene prices peaked in late 2008 and dropped in 2009 as low as the $0.30 per pound range. In late 2009 and early 2010, prices have rebounded to the mid $0.50 per pound range. Continued overcapacity will limit price increases and thus profit improvement.

Implications for Soybean Oil and/or Soybean Meal

Since the majority of styrene monomer is consumed in the production of polystyrene packaging and insulation foams, any petrochemical raw material or energy cost increase in the production of the monomer causes the final products, polystyrene foam or packaging, to increase. This reduces their cost-effectiveness compared with products such as polyurethane foam insulation containing soy oil derivatives, thus increasing the potential market for soy oil as an alternative chemical raw material.

Styrene is coming under increased pressure to be labeled a probable human carcinogen. This poses problems for worker exposure for those involved with the use of unsaturated polyester resins. Replacements for styrene are currently at a higher cost. This could provide opportunities for a soy-based product if more economical chemical alternatives to styrene could be made from soy materials than crude oil and/or natural gas.

CHANGES SINCE 2008

Since the prior study in 2008, prices of raw materials and unsaturated polyesters resin have decreased with the falling of petroleum prices, such as crude oil, and with the economic downturn. However, prices have started to increase again with increased petroleum prices. Soy oil prices are still low relative to glycols like propylene glycol used in unsaturated polyester resins. However, there have been limits to the amount that can be used before properties degrade. Opportunities exist for making chemicals that go into unsaturated polyester resins, such as the glycols and the acids. The pricing of soy oil and soybean meal relative to glycols and acids being used and the improvements in fermentation and separation technology will dictate whether these opportunities will be achieved. Continued pressure on listing the monomer styrene (which is at least 35% of most unsaturated polyester resins) as a "reasonably anticipated" carcinogen will greatly impact this market.

2.4 THERMOPLASTICS

This section represents the potential use for soy flour, or meal, and/or soy concentrate in the largest plastics market, thermoplastics, and the fastest growing type of thermoplastics, bioplastics.

The thermoplastic resins, which are characterized by their ability to be reformed on heating and easily recycled, find use in:

- Packaging applications: films, trays, molded shapes, bags, cushioning foams, garbage bags, milk bottles, etc.
- Building and construction applications: vinyl siding, coatings, pipes, insulation, etc.
- Transportation industry applications: interior trim, exterior body panels, lenses, etc.
- Electrical and electronic applications: appliances, office machines, semi-conductors, wire and cable, TV housings, switches, etc.
- Consumer and institutional products: medical devices, disposable food service ware, luggage, hardhats, plastic pools, credit cards, signs, footwear, etc.
- Furniture and furnishings: institutional and school furniture, stadium seating, counter tops, frames, lawn and garden furniture.
- Industrial machinery: engine and turbine parts, farm and garden equipment, chemical processing equipment, oil field equipment, etc.
- Adhesives/inks/coatings: adhesives and sealants, paper coatings, paints, ink, etc.

The use of thermoplastic resins touches nearly every product that we use daily.

Supply and Demand

Thermoplastic resin production in North American reached 102 billion pounds of resin in 2008, according to the American Plastics Council's year-end statistics. This was down more than 12.3% from 2007. There are 30+ major resin families that make up this volume. The major volume resin families include polyethylene, polypropylene, polystyrene, polyvinyl chloride, nylon and ABS. These large volume resins are all derived from natural gas or petroleum feedstocks. They are produced by a variety of proprietary processes. Often the same plastic resin can have quite different technologies employed to produce the resin.

The demand for thermoplastic resins is driven by their utility, cost benefit, technological innovation, new product development and global population growth. The nominal North American compounded average annual growth rate is estimated by various industry observers to be between 3%-5%. The 2009 final production numbers are not available but are expected by industry observers to be flat versus 2008 due to an increase in demand during the second and third quarters of 2009.

The newest category of thermoplastic resins and the fastest growing, called bioplastics, has continued to grow in spite of the global economic slowdown and has become an important thermoplastic product offering, especially in the packaging and consumer disposable articles market segments. Bioplastic materials are plastics whose raw materials are based wholly or in part on biomass. Historically, bioplastics derived from cellulose and then chemically modified were early bioplastic materials, e.g. cellulose acetate and ethyl cellulose. However, they were replaced in many applications by petrochemical-based plastics for cost performance reasons. However, in the last 12 years, new bioplastics based on agricultural products such as corn, potatoes, wheat, etc., that are more cost effective than the cellulosics have been commercialized.

Demand for films, bags, disposable food service items, etc., derived from bioplastics is driven by consumer desire for sustainable packaging materials and government action to encourage recycling and biodegradation of packaging waste. The global market for biodegradable polymers doubled in size between 2005 and 2009, and according to a recently released report from SRI Consulting, the global market is estimated to grow 13% annually from 2009 to 2014. The global market should reach over 1.0 billion pounds.

At the most recent United Nations climate summit in Copenhagen (December 7-18, 2009), the convention center that hosted the UN's official events was carpeted with a bio-fiber, Ingeo™, made from corn sugar and supplied by Natureworks, LLC, a wholly-owned subsidiary of Cargill. The carpet was produced by Sommer Needlepunch.

Feedstock Pricing

Since almost all large-volume thermoplastics, except for the cellulosics, depend on oil or natural gas for the starting raw material (the exception being the new group of bioplastic polymers), the thermoplastic resins as a whole experienced a tremendous run up in cost to manufacture, peaking in late 2008. The percentage change in a particular resin is a function of its raw material source, energy input to polymerize the monomer and the global capacity available over the time period. Since the last update in 2008, the price of oil more than doubled briefly to $140 per barrel before falling back to today's price of $80 per barrel, while natural gas increased to $7.50 per million BTU in early September 2008 from $6.83 at the end of 2007 before falling back to less than $4.00 per million BTUs (see chart on page 5). Natural gas follows the same trends as crude oil; however, some decoupling does occur during short periods due to regional pricing. Ethylene and polypropylene are the two major feedstocks for various polyethylene grades and polypropylene, which account for more than 50% of the plastics volume in the United States. These feedstocks will rise and fall with crude oil. These raw material crude oil price increases rippled down the supply chain for all resins. Propylene prices increased by more than 100% to $0.85 per pound in September 2008 from $0.40 per pound in 2006. Examples of similar price increases during the same timeframe can be found among several thermoplastic resin families (see following tables). Since September 2008, prices of major thermoplastic prices decreased during most of 2009 before beginning to increase in the 4th quarter of 2009. In spite of increased demand in the 4th quarter and increasing petrochemical prices, thermoplastics have still not returned to their 2008 highs.

The monomers used to make the commodity plastics (polyethylene, polypropylene, polyvinyl chloride, polystyrene) are derived from oil (naphtha cut) or natural gas liquids.

Petrochemical Intermediate Pricing

Year End (cents per pound)	2006	2007	2008 (early Sept.)	2008 Year End	2009 Year End
Ethylene	41.5	61.5	74.5	38	37
Propylene	40.5	62	85	30	54
Styrene	60.5	64	82	44.5	57
Naphtha	23	33	39	10	27

Thermoplastic Resin Pricing

Pricing of Selected Thermoplastic and Bioplastic Polymers Cents per Pound - December 2009			
Polymer Type (cents per pound)	**Price* (Sept. 2008)**	**Price* (Dec. 2009)**	**Comments** (large volume)
Polyethylene	95-110	70-91	HD - LD grades volumes
Polypropylene	100-118	85-92	Homopolymer
Polystyrene	108-115	78-80	General purpose
Polyester	96-101	66-88	PET bottle grade
Copolyester (EcoFlex)	190-195	210-220	Biodegradable hydrocarbon based
Polylactic acid	95-110	85-105	Very volume dependent
Polypropylene/starch blend	90-102	60-75	Volume dependent

*Various industry sources

CHANGES SINCE 2008

The cost of petroleum based thermoplastics, after first decreasing in 2008-09 in response to the reduced global demand created by depressed world economic conditions, has again begun to increase in response to improving global demand and increasing costs of hydrocarbon-based petrochemical building blocks. The increasing cost of petrochemical based polymers is again creating an opportunity for bioplastics as economically competitive replacements. Currently, the only significant use in thermoplastic resins of a soy derivative is epoxidized soybean oil (ESBO) used as a secondary plasticizer for flexible polyvinyl chloride (PVC) applications. It is normally used at less than a 5% level.

Until the recent price increases in petrochemical-based thermoplastics, polymers based principally on soy protein have had unfavorable cost performance profiles versus the competitive petrochemical-based thermoplastics. Currently, several USB New Uses Committee projects at Iowa State University and Washington State University are targeted at addressing the performance issues identified in the original work using both soy meal and modified soy oil.

SECTION 3 ADHESIVES FOR WOOD COMPOSITES

3.0 OVERVIEW

Adhesives are made from a wide variety of chemistries. This section will review and discuss the use of soybean meal/flour and derivatives in making adhesives for wood composites.

While other forms of adhesives have been and will continue to be researched, USB-sponsored efforts have primarily focused on soy-based adhesives for the major wood composite markets: oriented strand board, plywood, particleboard and medium-density fiberboard. Oriented strand board and softwood plywood are structural panels used in light weight construction where they provide the rigid envelope that ties the other structural elements of wood-framed buildings together. Particleboard and medium-density fiberboard are considered non-structural panels and are used in furniture and molding. Typical adhesive applications for these boards are restricted to interior use due to poor weathering properties and water resistance.

Major adhesive resins used for wood composites contain phenol or urea, plus formaldehyde (PF and UF). These chemicals are combined for use as binders or adhesives for the manufacture of various wood composites. Formaldehyde is made from methanol and urea is primarily made from natural gas via ammonia. Phenol is derived from benzene and propylene. Benzene is made from crude petroleum and propylene is made from natural gas in most of the world.

Soy meal/flour is being used commercially in formaldehyde-free glues for interior hardwood plywood. The soy-based glue is cost neutral to urea formaldehyde and avoids the environmental issue of formaldehyde emissions in the glue line in the manufacture and use of the board. Formaldehyde was classified as a known carcinogen in 2009 and current permissible levels are extremely low and in some applications must be zero. These restrictions in emissions have fueled research toward development of this soy-based technology for non-structural and structural panel applications.

The wood composites industry expresses the demand in square feet of production. In 2009, 30.0 billion square feet of structural and non-structural panels were sold in North America, down from 51.2 billion square feet sold in 2007. Eighty-two percent of that number is for oriented strand board and softwood plywood. By 2011, this number is expected to increase to 39.6 billion square feet. These values are significantly lower than 2008 demand due to the substantial drop in housing starts during the economic downturn beginning in the fall of 2008. US housing starts for 2009 were 0.55 million, a reduction of 39% from the previous year. US housing starts are expected to rebound in 2010 and increase to 1.26 million in 2011. (RISI, 4 Alfred Circle, Bedford, MA 01730; www.risiinfo.com)

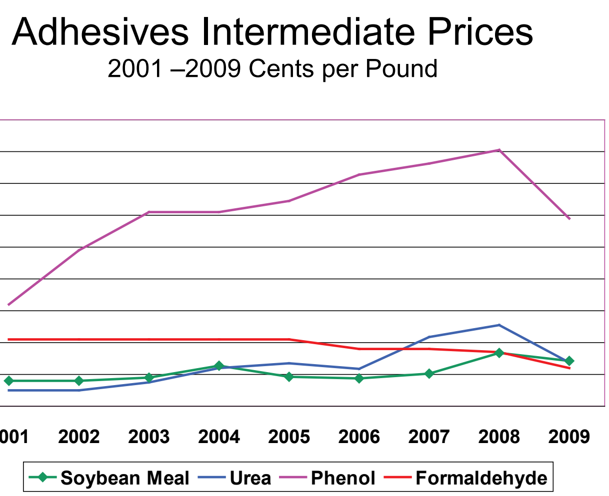
The total consumption of urea-, formaldehyde- and phenol-based resins in 2006 was 3.7 billion pounds. In 2009, the total North American consumption of all formaldehyde-based resins was 2.8 billion pounds. This drop in consumption is a product of the depressed construction and furniture markets in 2007 and 2008. A very slow recovery in the construction industry is expected in the next few years, with consumption of UF and PF resins increasing slightly to 2.9 billion pounds in 2010, and beginning to stabilize in 2013 at 3.74 billion pounds. The attractive mortgage rates and incentives are expected to invigorate the construction and remodeling markets in early 2010.

3.1 ADHESIVE FEEDSTOCK DATA

Soy meal/flour can be used as a replacement for current UF and PF resins. As recently as 2006, a soy flour formaldehyde-free adhesive was introduced for interior hardwood plywood to eliminate formaldehyde emissions in the glue line. These same kinds of products have also been introduced in particleboard and medium-density fiberboard. Soy derivatives are also being investigated for use in structural wood composites, such as oriented strand board and softwood plywood.

While soy meal/flour prices have gone up in the past few years, competing chemical intermediates have risen sharply in cost. The cost of cumene and benzene, key feedstocks for phenol resins, has shown very volatile pricing in 2008, rising 40% at the highest point. As with other markets, 2009 started off with substantially lower prices and ended on the upswing due to increasing feedstock prices and tight supply from production cuts. The year 2010 is expected to start off with a 20% increase in feedstock prices.

Urea prices showed a dramatic 256% increase at their highest in 2008 due to increased costs for ammonia. As expected, urea prices started low and peaked in fall of 2009 in response to the agricultural and diesel exhaust fluid demand, which is expected to drive the price of urea up in 2010 when the EPA mandates more widespread use of urea-based diesel exhaust fluid. Finally, methanol, a precursor to formaldehyde, has followed the same trend with a price increase of more than 175% in 2008, and then substantially reduced prices in 2009 due to the very poor performance of the construction sector. Formaldehyde consumption and pricing is strongly correlated to construction and usually tracks close to the GDP.



ADHESIVE FEEDSTOCK PRICE HISTORY (cents per pound)							
Product	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Soybean Meal	9.08	12.8	9.15	8.71	10.25	16.8	14.25
Urea	7.5	12	13.5	11.8	21.7	25.5	13.7
Phenol	61	61	64.5	72.8	76.3	80.5	58.9
Formaldehyde	21	21	21	18	18	17	13

Impact on End Product Pricing

The suppliers of formaldehyde have absorbed production cost increases in order to protect their market share in the face of a depressed housing and construction market and increased regulatory pressure. Formaldehyde prices have actually dropped 43% since 2004 to about $0.13 per pound. Forty percent of formaldehyde use is in urea formaldehyde (UF) and phenol formaldehyde (PF) resin production.

Urea pricing from UF resin suppliers has been very low in 2009 and is expected to remain low for the near future. Urea prices climbed rapidly in 2007 and again in 2008 before moderating in 2009. UF pricing will be very competitive to soy-based alternatives over the next year.

Phenol price increases moderated from highs of more than $0.80 a pound to about $0.60 per pound in early 2010 due to falling demand for its use in wood adhesives resulting from poor market conditions. This makes soy meal at a cost of about $0.14 per pound in January 2010 a good value for substitution of phenol in structural wood adhesives.

Implications for Soybean Meal/Flour

There are two driving forces for soy-based products to penetrate the wood composite market. The first is simply the potential for reduced cost. The second is in the case of non-structural panels, such as particleboard and medium-density fiberboard, where soy-based glues will prevent the formaldehyde emissions caused by the use of UF in the mill and its subsequent emission from the panel board glue line. Formaldehyde is now considered to be a known carcinogen and certain states, such as California, are striving to establish formaldehyde-free glue lines. In the case of structural panels, such as oriented strand board and softwood plywood, soy-based products can be produced with equal performance and lower costs. Formaldehyde emissions in the structural panel glue line are less of an issue, but there may still be concerns about its use in the manufacture of these boards.

The wood composites industry has taken advantage of soy meal/flour to make formaldehyde-free glue lines in non-structural wood composites, such as interior hardwood plywood. Columbia Forest Products successfully converted all of its hardwood plywood mills to new soy-based glues. Hercules and Heartland Industries formed a joint venture called H2H to make and market soy-based glues to the wood composites industry. Ashland has taken over these efforts when it purchased Hercules in 2008. Oregon State University, the original inventor of the soy-based glues for interior hardwood plywood, continues to do research supported by USB on new soy-based glues for the structural wood composite industry.

CHANGES SINCE 2008

The severe recession has produced a very turbulent response in consumption and, therefore, pricing in most industrial sectors, as the construction market has been most severely impacted. The roller coaster ride in prices of chemical intermediates peaked at its highest in August 2008 and settled into a low price slump in 2009. The year 2008 showed inflated prices for all intermediates that are derived from natural gas or petroleum feedstocks. Prices of chemical intermediates are expected to show modest increases in 2010. Competition with UF resins for applications not requiring low or no emissions standards will be difficult with soy-based alternatives on price alone. Prometheus has shown that partial substitution of PF with a soy component can offer a substantial cost savings while maintaining exterior durability.

There has been successful penetration of soy meal/flour based glues in non-structural wood composites, and the establishment of Ashland to specifically pursue soy-based glues in all types of wood composites was very timely. Tightening regulation of formaldehyde emissions and increased designer and consumer awareness continue to push non-formaldehyde-based formulations volume use to even greater levels. Prometheus has been successful in the development and promotion of a PF/soy adhesive for OSB, which has generated a significant amount of interest.

The impact of a depressed housing and construction market has currently slowed the overall demand for wood glues. In response, many plants that had been running at full capacity are now idle or operating at reduced production levels.

SECTION 4 COATINGS AND INKS

4.0 OVERVIEW

Historically, coatings and inks have been the largest industrial markets for the use of soybean oil. While coatings or inks may be complex formulations of many different ingredients, conventional coatings are comprised of two primary components, solid resins that form the final dried coating and a fluid component or carrier that allows the material to be applied as a liquid. The liquid is either evaporated or transformed into a cured solid after application to form a portion of the final dry solid coating.

Soybean oil has long been and continues to be used as both an ingredient in the solids resins and as a fluid carrier. For example, in soy newsprint inks, soybean oil is combined with petroleum distillates, typically napthenic oils, which form the fluid carrier for pigmented resins. Alkyd resins made from soybean oil are dissolved in solvents to make what is referred to as oil-based paints.

There are many types of coatings and inks where soy has the potential to compete. This report will focus on six of these areas:

- Architectural coatings
- Original equipment manufacturer (OEM) coatings
- Special purpose coatings
- Powder coatings
- Drying oils used in various types of coatings and inks
- Radiation cured inks

Some other types of coatings may also offer excellent potential for soy use, such as newsprint inks. Soy already has a strong presence in this market, primarily in colored inks, and the rising costs of napthenic oils may result in more substitution. In addition, research is being supported by the United Soybean Board for new applications of soybean oil in gravure and offset inks.

4.1 ARCHITECTURAL COATINGS

Architectural coatings are coatings for on-site application to interior or exterior surfaces of residential, commercial, institutional or industrial buildings. These coatings are protective and decorative finishes applied at ambient temperatures for ordinary use and exposure. Included in architectural finishes are household paints, stains, sealers and roof coatings. Solvent-borne or oil-based paints were once the leading products in this market, but have become secondary to water-borne paints, which are primarily formulated latex emulsions and are more environmentally friendly.

The primary resins used in architectural coatings are acrylic esters and vinyl acetate copolymers. These resins determine the gloss, hardness, stain resistance, block resistance, washability and durability of the final coating.

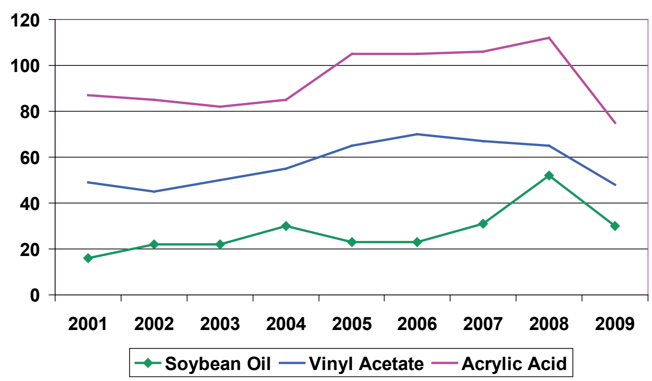
The acrylic esters and polyvinyl acetate copolymers are derived from acrylic acid and vinyl acetate, respectively. Vinyl acetate is derived from ethylene, acetic acid and oxygen. Acrylic acid is prepared from acetylene, carbon monoxide and water or alcohol. Acrylic acid can also be prepared by the oxidation of propylene.

Supply and Demand

In 2009, it is estimated that 640 million gallons of architectural coatings will be sold, having a value of $8.0 billion. In 2008, shipments were 682 million gallons, having a value of $8.67 billion. Architectural coatings shipments declined 6.0 % in 2009 due to the continuing poor housing and construction market, but still represent 56% of total paints and coatings shipments. Resin consumption for the US coatings market was $23.8 billion in 2006 and is expected to grow to $25.0 billion by 2011.

Latex Coatings Intermediate Prices

2001 – 2009 Cents per Pound



Feedstock Pricing

Acrylic acid and vinyl acetate, two of the primary monomers, are used to make acrylic esters and polyvinyl acetate copolymers, respectively, for use as coating resins. They remain in plentiful supply due to the poor housing and construction market, which affects the demand for paints and coatings.

Vinyl acetate prices have declined from $0.65-$0.70 a pound in mid-2008 to about $0.45-$0.50 a pound in mid-2009. Since then, prices have trended upwards $0.03-$0.05 per pound to reflect rising costs for energy and raw materials.

Acrylic acid and acrylic ester suppliers had decreased the price of their products from $1.00-$1.25 per pound in 2008 to about $0.57-$0.60 per pound in early 2009. As the price of crude oil began to rise in March 2009, the prices of acrylic acid and its esters began to rise again to reach $0.75 a pound at the end of 2009. It appears prices will continue to climb in 2010 as Dow Performance Monomers announced a price increase in January 2010 of $0.10 per pound for glacial acrylic acid, butyl acrylate, ethyl acrylate and methyl acrylate.

Implications for Soybean Oil

Soybean oil in the last several years has begun to penetrate the architectural coatings markets with new applications in roof coating, stains, sealers, industrial paints and house paints. Even though the price of soybean oil continues to rise in concert with prices for crude petroleum and, therefore, synthetic resins, it remains a good value for use in paints and coatings. Soybean-oil - based paints can reduce the odor of petrochemical-based paints, lower the volatile organic components (VOCs) and offer green, sustainable alternatives. The issue of sustainable, biorenewable raw materials has become a major thrust for coatings formulators, providing a significant opportunity for soy oils. Sherwin Williams, Rust-Oleum and New Century Coatings have coatings programs supported by USB to take advantage of the bio-sustainability and low VOCs offered by soybean oil chemistry.

CHANGES SINCE 2008

At a recent American Coatings Conference, the National Paints and Coatings Association ranked waterborne technologies as the most important technology for the industry. The USB has actively supported new soy-based waterborne technologies at two key paint formulators, Sherwin Williams and Rust-Oleum.

4.2 ORIGINAL EQUIPMENT MANUFACTURER (OEM)

Coatings formulated specifically for original equipment manufacturers to meet application conditions and product requirements, and which are applied to such products during the manufacturing process, are called OEM coatings. Current applications being supported by the USB include soy polyols for coating sheet molded plastics for agricultural equipment and coatings for consumer electronics, automotive parts and athletic foot wear.

Supply and Demand

In 2009, the quantity of OEM coatings shipped was estimated at 259 million gallons, a 25% drop from the 344 million gallons of 2008. The shipment value for this segment dropped 20% from $5,662 million in 2008 to $4,517 million in 2009. Both declines are a reflection of the poor market conditions for automobiles, trucks and furniture.

Feedstock Pricing

The feedstock pricing of soy polyols for the OEM industry is covered under the PLASTICS section of this report.

Implications for Soybean Oil

There is a great deal of interest in the use of soy polyols to replace petrochemical polyols to satisfy corporate Green programs. The most interest lies in the biobased sustainability of soy versus petroleum and natural gas feedstock chemicals as it relates to price stability and supply availability. PPG and Sherwin Williams are leading coating industry suppliers that are seeking to use soybean oil in industrial coatings to replace petrochemical polyols.

CHANGES SINCE 2008

PPG has progressed to trials with new industrial high-performance soy-based polyols with a major footwear manufacturer in a pigmented coating over leather and plastic, and Battelle/Sherwin Williams are running trials with a new soy-based polyol as a liquid coating over sheet molded plastic parts for agricultural implements.

4.3 SPECIAL PURPOSE COATINGS

Special Purpose Coatings are made up of a number of dissimilar product classifications. The major applications are industrial maintenance, traffic-marking paints and automobile refinish coatings. These coatings are primarily used to protect surfaces and designed to perform a special purpose within the domestic economy.

The primary resins used in Special Purpose Coatings are epoxies, polyesters, soy alkyds and acrylic chemistry. The main components of polyesters are propylene glycol, maleic anhydride and styrene. Epoxies are derived from epicholrohydrin and bisphenol A. The primary ingredient in epoxies, epichlorohydrin, is derived from polypropylene. Many of these components are also covered within the PLASTICS section of this report. The acrylic chemistry has been covered under the section on ARCHITECTURAL COATINGS.

Supply and Demand

In 2009, the quantity of Special Purpose Coatings was estimated at 168 million gallons, a drop of 14% from the 2008 quantity of 196.3 million gallons. There was also a decrease in value as the market in 2009 was at $3,721 million, down 19% from $4,605 million in 2008. The declines reflect the general economic slowdown in the construction industry.

Feedstock Pricing

The prices of epoxy resins have plummeted from $1.65 per pound in 2008 to about $1.05 per pound in January 2010. The reason for the price decrease has been the slowdown of demand in the automotive, electronic and construction industries. Price increases are expected to resume to a level of $1.20 per pound as the economy improves in 2010.

Implications for Soybean Oil

Soy alkyd resins were one of the first materials developed for this coating category and still are popular for some uses. They account for about 20% of the resin volume in this coating category. Ten years ago, soy alkyds were very popular in traffic paints, having about 60% market share. The solvent soy oil alkyds lost favor to more environmentally friendly water-based acrylic technology and now have only about 10% market share.

CHANGES SINCE 2008

This is a new coatings category not included in the 2008 Pricing Study. USB projects have targeted the traffic paint market to regain the soy-based market share lost to water-based acrylates. USB is supporting Reichhold Chemical in developing a water-based soy alkyd coating that will be more environmentally friendly than solvent-based alkyd technology.

4.4 POWDER COATINGS

Powder coatings are 100% solids coatings primarily applied to metal for protective and decorative purposes. Major applications are in office furniture, appliances and automotive parts. Relative to liquid coatings, powder coatings offer faster cure, less waste and no solvent or recovery issues. Powder coatings are the largest volume category within OEM coatings and second in dollar shipments.

The primary resins used in powder coatings are epoxies, polyesters and epoxy/polyester hybrids. The main components of polyesters are propylene glycol, maleic anhydride and styrene. Epoxies are derived from epichlorohydrin and bisphenol A. The primary ingredient in epoxies, epichlorohydrin, is derived from polypropylene. Many of these components are also covered within the PLASTICS and SPECIAL PURPOSE COATINGS section of this report.

Supply and Demand

The demand for the quantity of powder coatings in 2008 dropped to 310 million pounds, which is a 14% drop from the 360 million pounds sold in 2007. The quantity of powder coatings in 2008 was $853 million, which equates to an 8% drop from the $927 million sold in 2007. The market is consolidating and maturing and potential customers are not investing the capital required to convert to powder coatings.

Feedstock Pricing

As covered in the section on Special Purpose Coatings, epoxy prices have declined considerably from a high of $1.65 per pound in 2008 to about $1.05 per pound in January 2010. The depressed economy has driven down prices, but with the increase in petrochemical feedstock prices and higher demand in 2010, prices for epoxies may rise to $1.20 per pound in 2010.

Prices for polyester-based powder coating resins were $1.70-$2.20 per pound in 2008. DSM, the major supplier, raised its prices 6%-7% in late 2009. These price increases resulted from increases in such feedstock chemicals as terephthalic acid, isophthalic acid, adipic acid trimellitic anhydride and ethylene glycol. The major suppliers of polyester powder coating resins are Reichhold, DSM and Cytec.

Implications for Soybean Oil

There is potential for soybean oil to be substituted for a portion of the intermediates used in making resins for powder coatings. Research continues to develop powder coating resins with the highest amount of soy in the resin to provide a low-cost, renewable resource competitive with petrochemical resins.

Battelle Memorial Institute, with support from USB, has identified powder coating technology for both low and standard temperature curing. Standard cured powder coatings typically are applied on metal where temperatures of 350-400 degrees Fahrenheit are tolerated. The same technology can be modified for temperature-sensitive substrates, such as certain plastics and medium density fiberboard. These low-temperature powder coating products could expand the potential market by another $800 million.

In order to quickly commercialize this new technology, Battelle has partnered with Hexion to penetrate this market. Both are working with Deere to run trials on metal agricultural implement panels and in other industrial applications.

CHANGES SINCE 2008

Many other powder coating formulators, such as Dow and Akzo Nobel, have developed low temperature curing powder coatings so there are more technologies available for this application than there was in 2008. Since the 2009 acquisition of Rohm & Haas by Dow, Dow has sold its powder coating business to Akzo Nobel, which makes it the world's largest manufacturer of powder coatings.

4.5 DRYING OILS

Certain coatings and inks use vegetable oils as binders/solvents in their formulations. The most important use of these drying oils is in oil-based alkyd paints and certain inks, such as newsprint, sheet fed and cold set inks. One of the most popular drying oils in addition to soybean oil is linseed oil, which is derived from flax seed.

Supply and Demand

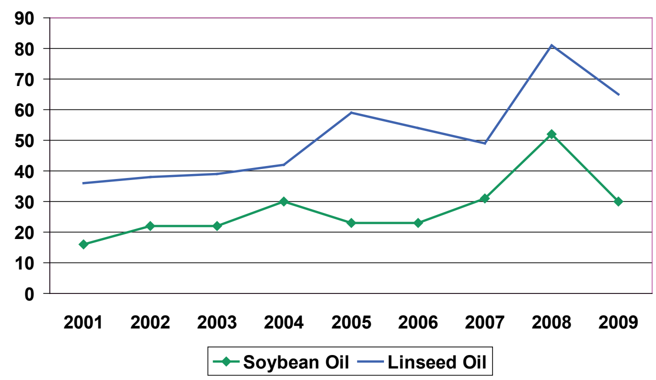
In 2009, 190 million pounds of linseed oil were produced in the United States. About 40% is used in oil-based coatings, while 30% is used in inks. The production of linseed oil has varied from 195 million pounds in 2002 to as high as 320 million pounds in 2006. ADM and Cargill are the two largest suppliers of linseed oil. The major flax seed producing states are Minnesota, South Dakota and North Dakota.

Feedstock Pricing

Linseed oil still maintains a premium price because of its faster drying properties relative to soybean oil. This price premium should be sufficient to allow for some additional opportunity for identity-preserved soy varieties with superior drying oil characteristics or for chemical modification of conventional soybean oil.

Drying Oil Prices

2001 – 2009 Cents per Pound



Implications for Soybean Oil

Linseed oil has faster drying properties than soybean oil in coatings and inks and can therefore command higher pricing. Pricing reached about $0.65 per pound in 2009. With support from USB, Iowa State University tried to produce conjugated soybean oil by a photolytic process that had faster curing properties than regular soybean oil. After much work the project was discontinued because the process did not appear to be presently economically viable. Until a superior and cost-effective process is identified, linseed oil will continue to exhibit faster drying properties than regular soybean oil.

CHANGES SINCE 2008

During 2009, Monsanto introduced an experimental stereodonic acid (SDA) soybean oil that is more unsaturated and, therefore, may be more reactive and faster drying than traditional soybean oil. These properties of the SDA oil could be useful in printing inks and coatings as an offset to linseed oil.

4.6 RADIATION CURED COATINGS

Radiation cured coatings, such as those used in graphic arts, packaging, wood furniture, fiber optics, electronics and automotive parts, are being accepted as excellent alternatives to conventionally cured coatings. Radiation cured coatings provide advantages to conventional cured coatings due to lower VOCs, quicker processing, space savings in plants and very durable finishes. Tighter environmental codes and regulations, along with advances in UV/EB technology and more collaboration among suppliers, are big drivers for its growth.

The primary resins used in radiation cured coatings are acrylic and acrylic polyester blends. These resins allow for durable, high-gloss quality products. Acrylics are derived from acrylic acid, a propylene or acetylene derivative. Polyester resins are usually made from maleic anhydride, propylene glycol and styrene. All these products are derived from crude oil during refining or from natural gas during cracking.

Supply and Demand

Demand for radiation cured coatings in North America in 2007 was 238 million pounds, valued at about $1billion. Worldwide, radiation cured coatings represent about 2% of the total coatings market. It is estimated the growth will be flat for the next few years. Printing and packaging demand for these coatings will be areas of strong interest.

Feedstock Pricing

Prices for polyester acrylates used in this market segment have remained steady at $5.00-$10.00 per pound. Prices remain high for these polymers since this is a niche market for specialty resins where premium pricing is possible. The soy/acrylic polymers are being sold for about $3.00-$5.00 per pound.

Implications for Soybean Oil

Lehigh/Northampton University has been supported by the USB in several research projects to use chemically modified soy oil to replace more expensive acrylic and polyester polymers in printing inks. The objective has been to reduce the cost of using more expensive polymers and avoid the odors associated with acrylic resins. Work to date shows chemically modified soy oil can replace a portion of the acrylic or acrylic polyester blends in UV printing inks and potentially reduce curing time and improve pigment wetting.

On another front, the USB has funded PPG to develop glycerin based UV-curable industrial clear and pigmented coatings as part of its emphasis on new green coating technology. The objective is to develop a new oligomer to reduce the carbon footprint and toxicity of using isocyanates and other petrochemical resins.

CHANGES SINCE 2008

A major resin supplier has agreed to run extensive printing trials in lithographic inks with the new soy/acrylic UV resins developed by Lehigh University. The trials will measure the printing qualities of the printed paper and the performance on the resin on the printing presses.

The new soy-based polyurethane developed by PPG to be used as a clear or pigmented coating in footwear will undergo trials by a major footwear manufacturer in 2010.

The American Coatings Association still ranks radiant coatings as the second most important technology for the industry. Waterborne coatings remain number one. Because of the industry's strong interest in radiant coatings, the United Soybean Board is supporting some new projects with North Dakota State University to develop new soy-based polymers for UV coatings. One project is concerned with developing a non-isocyanate soy urethane acrylic polymer to be used as a low VOC environmentally friendly coating for wood, metal, and plastics. The other project is concerned with using simple sugar in combination with soy/acrylics to provide a better, lower-cost resin.

SECTION 5 SOLVENTS

5.0 OVERVIEW

Industrial solvents are used as component ingredients in formulated products or as processing aids in manufacturing to clean, remove or solubilize other materials. The solvents market encompasses a wide variety of products and end uses, including industrial, home and institutional cleaners, substance removers and carrier solvents in coatings, inks and personal care products.

Due to increasing regulatory pressure and consumer awareness, market opportunities are growing for environmentally friendly "green solvents" and higher value specialty solvents to replace conventional hydrocarbon and chlorinated solvents. This demand growth will be assisted by rising prices for petrochemical solvents as a result of record high pricing of crude oil and natural gas feedstocks.

The primary soy-based industrial solvent is methyl soyate or soy methyl ester (SME), the same product used as biodiesel fuel. Considerable research has gone into the development of new solvent uses for methyl soyate supported by USB and industry. Many market support resources have been provided for methyl soyate with USB funding, including a formulary guide, a solvent quality standard, container packaging materials research, VOC and toxicity testing, and solvent property and disposal research. More recent research by BioSpan Technologies has produced a family of new soy-based solvents that offer improved performance properties that will create additional market opportunities for broader conventional solvent replacement and the creation of new use applications.

Supply and Demand

Annual US solvents demand is about 12 billion pounds with minimal market growth (1%). The mix of solvent products available will, however, change dramatically under environmental and regulatory pressure. Green solvent use is projected to grow from 6% of market demand in 1995 to 14% by 2012. Market demand will, however, be dictated by recession recovery and petroleum feedstock prices.

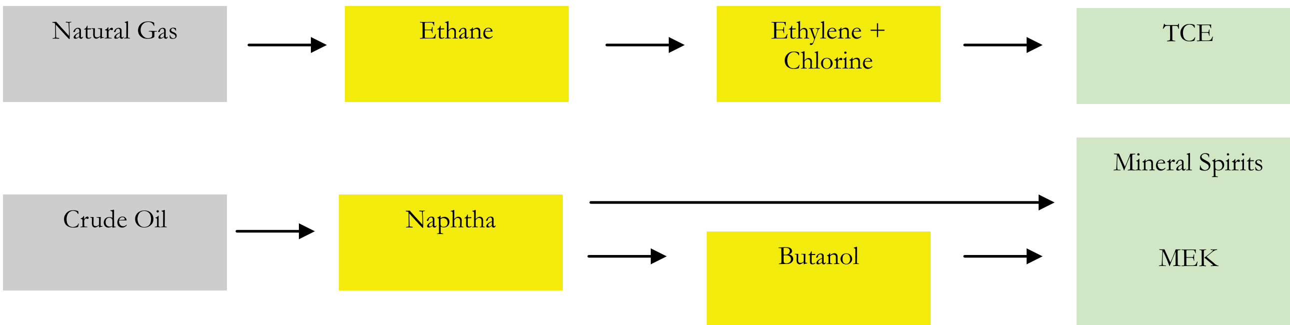
Methyl soyate (SME) is produced by transesterification of soybean oil and methanol. US production of SME in 2009 is estimated at about 1.9 million pounds. While most SME is sold as biodiesel fuel, market demand for methyl soyate industrial solvents has grown to about 45 million pounds annually. It is used in a wide variety of end-use applications that include parts cleaners and degreasers, general purpose cleaners, paint strippers, adhesive, ink and graffiti removers, and hand cleaners. Market demand for biosolvents and methyl soyate is growing at a positive rate while demand for hydrocarbon and chlorinated solvents is flat or declining.

5.1 COMPETITIVE PRODUCTS

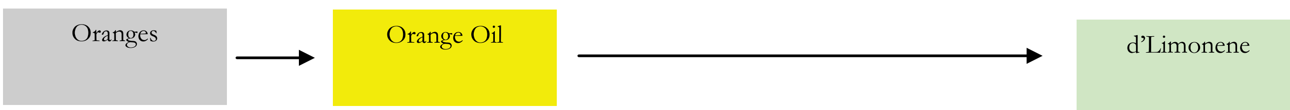
In the market applications mentioned above, methyl soyate competes with and can replace petrochemical solvents, such as trichloroethylene (TCE) and methyl ethyl ketone (MEK); hydrocarbon solvents, such as mineral spirits; and other biosolvents, such as d'Limonene. Methyl soyate is typically used in formulated products but not as a neat solvent. Petrochemical solvents are derived from either natural gas or crude oil while d'Limonene is made from citrus oil.

INDUSTRIAL SOLVENT FEEDSTOCKS

PETROCHEMICALS



d'LIMONENE



Solvent Price Trends

TCE is based on the hydrocarbon feedstock ethane that is produced from natural gas. Mineral spirits and MEK are produced from crude oil and naphtha, while d'Limonene is made from citrus oils. Since the last publication of this Pricing Survey in late 2008, crude oil and natural gas prices escalated to record levels then declined as the recession set in. Concurrently, global seed oil prices, including soybean oil, escalated and then declined in 2009. The uniform cycling of all solvent market pricing has allowed methyl soyate to remain competitive but has slowed market demand growth.

SOLVENT PRICING HISTORY
Cents per Pound

	2003	2004	2005	2006	2007	2008	2009
Methyl Soyate	62	57	60	62	65	90	65
Mineral Spirits*	50	60	67	60	62	69	61
MEK	35	67	68	62	69	68	60
TCE	70	70	70	53	48	54	64
d'Limonene	150	75	115	122	128	130	120

*High Flash Mineral Spirits

Implications for Soybean Oil

There are many petrochemical solvents with which methyl soyate competes. The primary replacement opportunities remain:

SOLVENT	US MARKET DEMAND 2008 Million Pounds per Year
TCE – Trichloroethylene	235
MEK – Methyl Ethyl Ketone	430
Mineral Spirits (Solvent 140)	200
d'Limonene	120

In addition to the significant price escalation of these solvents, they create several environmental disadvantages: high VOCs, flammability and toxicity issues that affect worker health and safety. Soy-based solvents offer better safety properties, cost-competitive performance and other intangible values, such as reduced regulatory reporting, lower insurance premiums and lower waste disposal costs. The new soy-based solvents being developed by BioSpan Technologies should provide additional performance advantages, market application growth and conventional solvent replacement opportunities upon patent issue.

There has been some concern about the continuing availability of SME for industrial solvent use in competition with biodiesel while market demand for biodiesel was escalating rapidly. With the escalation of soybean oil pricing and the current uncertainty of the continuation of the biodiesel tax incentive, however, biodiesel profitability has dropped and with it plant production rates, deflating the pressure on methyl soyate industrial solvent supply. Methyl soyate will continue to offer a higher value, stable, profitable, sustainable and growing market opportunity as an industrial solvent.

CHANGES SINCE 2008

The primary event impacting the solvent market since 2008 was the severe recession. Following the rapid escalation of hydrocarbon, petrochemical and seed oil prices during the first half of 2008, the US recession hit in November 2008 and purchasing of all chemicals and solvents dropped sharply. Inventories of all chemicals were depleted for most of 2009, and only in late 2009 were starting to be rebuilt. US chemical demand including industrial solvents was estimated to have dropped 40% in 2009. With these major factors affecting supply and demand for all chemicals, the relative price structure of green solvents vs. petrochemical solvents did not change but rose and fell together.

The longer term market forces influencing green versus conventional solvents demand continue to drive purchasing decisions despite the severe economic disruption. Environmental and regulatory pressure on conventional petrochemical solvents continues. Demand for chlorinated and petroleum solvents will stay flat or decline, while green solvent use will continue to grow as alternative replacements or in new product use. The cost-performance competitive posture of biobased solvents, especially methyl soyate, has stayed relatively the same as awareness and acceptance of its use grows with recession recovery.

SECTION 6 LUBRICANTS

6.0 Overall Lubricant Base Oil Outlook

Overall US lubricant demand tracks closely with GDP with demand split about equally between industrial and consumer (primarily automotive) segments. As the economy recovers from the recession, lubricant demand and pricing are expected to rebound to pre-recession levels. Early 2010 price increases appear to be holding and demand is steady. Typical seasonal fluctuations are expected to resume in March/April 2010. Longer term lubricant demand is expected to be influenced (mostly downward) by structural changes in the market, including consolidation within key industrial segments (chemicals, transportation, paper, equipment manufacturing and metals); reduced demand from the automotive segment (growth of electric vehicles and reduced oil usage driven by pressure on fuel economy and emissions); movement of manufacturing off shore; demand growth in Asia; and regulatory and social pressures for sustainable, or green, products.

Supply and Demand

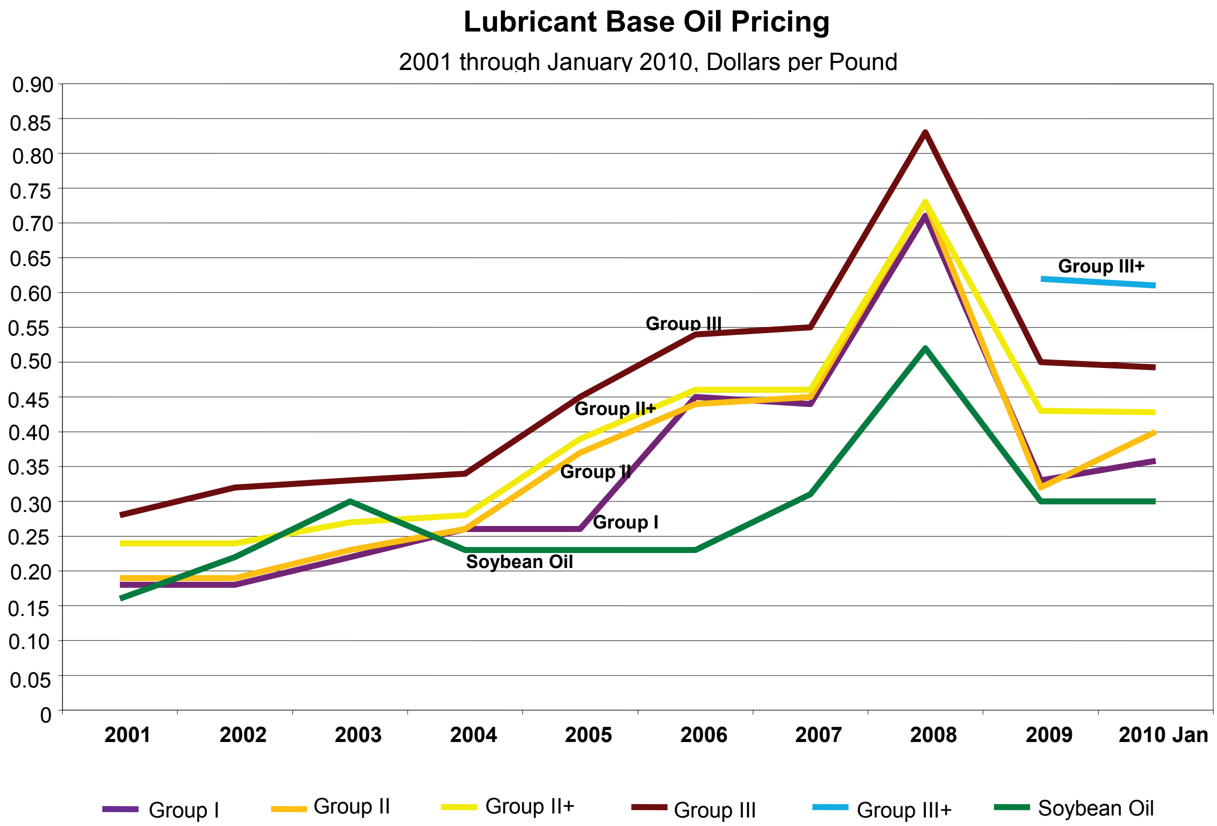
Current US petroleum base stock capacity outstrips demand. Production of API Group I base stock will likely continue a 20 year decline as refiners shutter less profitable operations and as the remaining refineries continue the transition from solvent systems to hydrocracking to meet the demand for higher quality base stocks and fuels. The reduced supply of Group I base stocks maintains the price for Group I very near the price of higher quality grades. Seven Group I plants remain in North America with a total of 12 million tons per year capacity. Increased demand for Group II and III base stocks has resulted in new off-shore capacity in China, Malaysia, Indonesia, Taiwan, Russia and the Middle East. Chevron has announced one capacity expansion in the US (Pascagoula). Crude oil pricing will continue to be the primary driver in petroleum-based lubricants pricing. A recent assessment suggests that not only do base oils follow crude oil pricing on the way up, but also on the decline.

While the trend for petroleum-based oil production is to move off-shore, both supply and demand for US biobased oils are increasing, with one market share source estimating share at 1%. As a harbinger of biobased lubricants' future in the US, European market share is estimated to grow to 18% in 2010. A footnote is that regulations in Europe require at least 50% renewable content to be considered biobased, which means that market share estimates may include blends with petroleum oil and synthetics. Biobased hydraulic fluids are growing 5%-10% per year and now represent 2%-4% (US) and 3%-7% (EU) of the hydraulics markets. Advances are due to performance, cost and renewability factors. Synthetics are reported to represent one third of the European lubricants market.

Factors influencing the US demand for biobased oils include supply availability, advances in formulation performance, chemical and genetic advances in the composition of the oils, and regulatory and social demand for sustainable and environmentally friendly lubricants. Of the biobased oils, soybean oil is the most well researched in the field of lubricants. Soy-based lubricant applications include packaged household lubricants, industrial hydraulic fluids, food grade hydraulic fluids, transformer fluids, transmission fluids, chain lubricants, gear lubricants, compressor lubricants and greases.

Price Trends

In the fourth quarter 2009, overall lubricant pricing appeared to stabilize. Early 2010 price increase announcements ($0.30–$0.35 per gallon in January) appeared to gain traction with demand stabilizing. Soybean oil (SBO) pricing appears to have been slightly less volatile through the recession, as price dependency is diversified beyond petroleum to also include factors such as agricultural yield, alternative use demand and weather patterns.



	Group I	Group II	Group II+	Group III	Group III+	Soybean Oil
2001	0.18	0.19	0.24	0.28		0.16
2002	0.18	0.19	0.24	0.32		0.22
2003	0.22	0.23	0.27	0.33		0.3
2004	0.26	0.26	0.28	0.34		0.23
2005	0.26	0.37	0.39	0.45		0.23
2006	0.45	0.44	0.46	0.54		0.23
2007	0.44	0.45	0.46	0.55		0.31
2008	0.71	0.73	0.73	0.83		0.52
2009	0.33	0.32	0.43	0.50	0.62	0.30
2010 Jan	0.36	0.40	0.43	0.49	0.61	0.30

Sources include Lubes ‘n Greases

Group IV base oils and formulated lubricants follow similar pricing trends as with Groups I, II and III. While prices for polyalphaolefins (PAO), polyglycols (PAG) and other synthetics have not generally been published, some PAO data is available for 2010:

Group IV (PAO) Pricing – 2010

Viscosity, cSt	January 2010 Price $/gal (drums)
2	9.60
5	10.00
8	10.35
10	11.99
40	18.77
100	21.48

Source: Allegheny Petroleum

Implications for Soybean Oil

Petroleum lubricant base stocks are higher priced than refined and high oleic soybean oil. Higher prices for Group I base stocks will benefit demand for soybean oil in markets such as total loss lubricants where the limited oxidative stability of soybean oil is less of a performance issue. At current pricing, high oleic SBO has the potential to be a cost-effective replacement for a portion of Group II+ and/or Group III oil once it is widely available, even with a premium for identity preservation. Improved oils will likely also be of use in transformer dielectric fluids. In summary, SBO can provide advantages in viscosity index, volatility, pricing and renewability. SBO will likely require additional additives to improve oxidation stability and pour point.

Growth Opportunities

An estimated 6% to10% of lubricants contain new basestocks, including Group IV (primarily polyalphaolefins) and Group V (that includes other synthetics, esters, re-refined oils, naphthenic oils, vegetable oils and oils from animal fats). White oils, which are highly refined and chemically modified petroleum oils made from Group I and Group II basestocks, are also included as non-conventional basestocks though their uses include many non-lubricant applications.

Avenues for growth of SBO lubricants include the following:

- Formulation and testing advances
- Chemical conversion of the oils for performance features
- Genetic engineering of the bean and thus the oil
- Mechanical engineering of the lubrication system
- Blends with other petroleum and synthetic oils to help meet performance and regulatory requirements.

CHANGES SINCE 2008

As the recession of 2008–2009 deepened, prices and demand fell dramatically, consistent with GDP and the economy. US lubricant demand is equally split between industrial and consumer (auto) demand, both of which were severely affected. Lubricant price points saw two major decreases totaling $1.50-$2.00 per gallon during this time period. This effect is expected to be cyclical with full rebound in the next one to two years.

SECTION 7 FIBERS

As fibers represent a new market to this survey of recent chemical price trends, more detail is provided for the reader to grasp the details of this market and its potential opportunity for soy use.

7.0 Fibers Market Overview

Fibers are a general term used to identify products in a broad market that encompasses textiles, nonwovens, films, ropes, threads, carpets, filters, membranes, tirecord, airbags, hosiery and many others. In general, they represent products that have textile-like characteristic properties of tensile strength and flexibility. The focus of this summary will be textiles and nonwovens applications only.

Fibers are the most basic raw material for the textile industry. They are thread-like strands that are converted into yarns with the help of textile machines. Fibers are also categorized as filament or staple fibers. Fibers in the form of strands are called filaments. Very short fibers are known as staple fibers.

For centuries, natural fibers had been the preference for textile manufacturers due to their comfort and easy accessibility. However, natural fibers are continually being replaced by the less expensive, better performing synthetic fibers in most market applications.

Fiber Types – Natural, Man-made Synthetic, Man-made Regenerated

Fibers are made from either natural or man-made synthetics sources. Cotton and animal fur are examples of a natural fiber. Man-made fibers fall into two categories: synthetic or regenerated. A synthetic fiber is chemically made, typically from petroleum-based products. Examples of man-made synthetic fibers include polyester, polyolefins (polypropylene and polyethylene), nylon, acrylics, polyacrylonitrile and polyvinyl alcohol. Regenerated fibers, on the other hand, are made from chemically induced transformations of natural polymers. They are either protein- or cellulose-based, such as soy, wood pulp and bamboo. Examples of man-made regenerated fibers are Azlon (proteins) and cellulosics (acetate, rayon and lyocell).

The United States Federal Trade Commission established regulations under the Textile Products Identification Act for fiber identification beginning on March 3, 1960. This guideline has been revised many times with the surge in development activities for new synthetic fibers.

Global fiber production is predominately polyester at 38%, cotton at 30% and olefins (polyethylene and polypropylene) at 22%. There are other categories such as cellulosics, wool, silk and protein-based fibers.

The required properties of textiles are generally the feel to the hand, flexibility, capability to change shape without resistance, durability, dyeability and shrinkage. Other key characteristics are their stability over a range of temperatures, strength, elasticity and extensibility. General properties that are also critical to end-use applications are:

- Surface characteristics, such as friction and softness
- Environmental stability, such as resistance to sunlight
- Thermal and chemical stability
- Abrasion resistance
- Moisture absorption

- Resistance to bacteria, yeast and fungus
- Wetting characteristics
- Static build up
- Color and luster

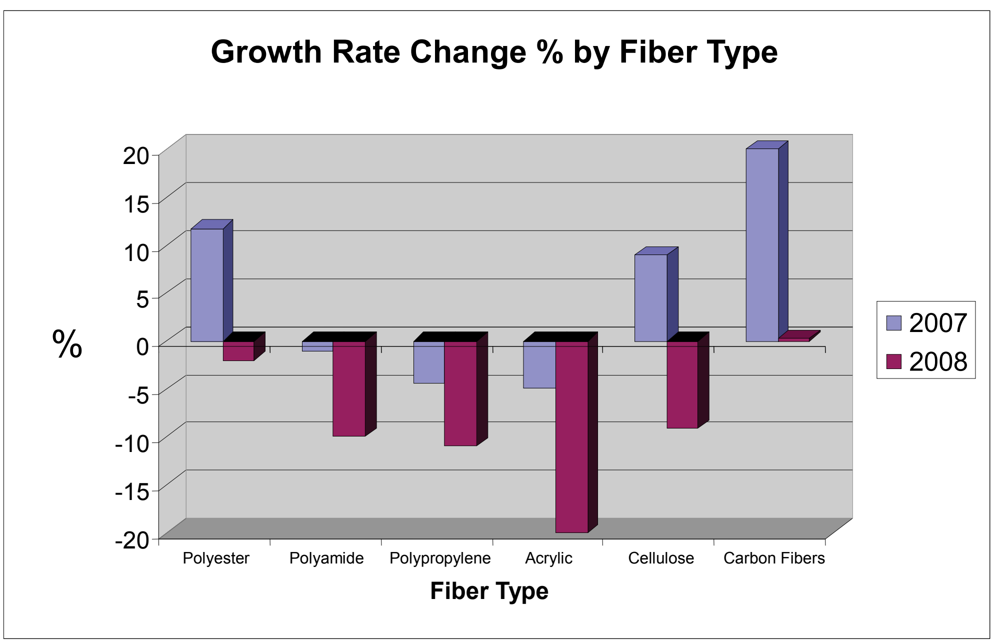
Supply and Market Demand - Textiles

World demand for manufactured textile fibers is forecasted to increase 5.5% per year to more than 137 billion pounds by 2012. Overall growth will be supported by the continued replacement of natural fibers by lower cost, better performing man-made alternatives in many market applications. US textile sales are forecasted between $95-$100 billion. The amount of cotton processed is estimated at 3 billion pounds. The amount of synthetic and cellulose fiber manufactured in the US is estimated at 15 billion pounds.

The fiber market will also benefit from a generally sound global outlook as the signs of economic recovery occur. Increases in industrial activity will promote gains in the technical yarns and fabric markets (e.g., tire cord, airbags and geotextiles), while the rising level of personal income in both developed and developing countries will promote demand for textile fibers used in apparel and household items such as furnishings, bed sheets, towels, blankets and quilts, as well as floor coverings.

All fiber types have been negatively impacted by to the economic downturn during 2008 and 2009. Total fiber production was down 6.7% for 2008, for a total of 67.3 million tons. Filament yarns have declined by 2.8% and staple yarns by 8.8%. The US textile industry, however, continued its long-term decline. October 2009 reported 411,200 current employees with a loss of 259,300 jobs since 2004. A modest recovery is forecasted in 2010.

Demonstration of this downturn is indicated in the change in growth rates below for 2007-2008 for the major polymer types.



The US is the biggest textile- and apparel-consuming country in the world. Detailed in the table below are the US consumption rates from 2004-2008. All product lines have been impacted by the manufacturing decline.

Textile Fiber Consumption in US by Product Line
Thousand Metric Tons

	2004	2005	2006	2007	2008
Bedspreads	90.1	79.3	78.5	70.1	56.8
Blankets	145.7	131.8	105.1	94.6	76.1
Sheets	467.3	367.2	290.4	206.3	183.7
Towels	198.1	169.5	95.3	95.3	38.2
Narrow Fabrics	3.5	3.0	3.3	3.1	2.4
Drapery	183.4	170.5	124.0	110.8	95.0
Upholstery	512.9	446.4	336.4	292.3	258.0
Other Home Textiles	140.4	124.1	107.1	94.8	85.8

US manufacturing trend from 2005-2008 for several polymer types manufactured is detailed in this next table.

US Textile Fiber Production by Fiber Type
Thousand Metric Tons

	2005	2006	2007	2008
Olefin-fiber	1008.0	962.0	970.0	832.0
Olefin-film	363.0	285.0	319.0	284.0
Acrylic	64.0	55.8	54.2	-
Nylon	1082.1	1022.7	936.7	741.1
Polyester	1419.7	1331.8	1240.1	1060.4
Acetate (Americas)	319.0	312.0	304.0	308.0
Cotton	1152.0	1070.0	879.0	752.0
Total	5407.8	5039.3	4703.0	3977.5

Supply and Demand – Nonwovens

Nonwovens are another fiber market, currently a 500-billion-pound business. Global sales in 2009 are predicted to total $12 billion. The global sales for nonwoven fabrics are predicted to be $5.1 billion and $6.9 billion for wipes.

Nonwovens processing is either by web formation or direct laid, which ultimately determines the end-use applications.

Web formation is either drylaid or wetlaid:

- Drylaid nonwovens include:
  - Carding, where a series of wire-covered rollers comb, remove or rearrange and raise fibers to the surface. The web is transferred to a card lapper for web formation and then bonded either chemically, mechanically or thermally.
  - Airlaids utilize air to move the fibers through the formation process. The fibers are moved through a series of wire-covered rollers to a screen drum or belt where air is suctioned through the screen arranging the fibers and forming the web and then bonded either chemically, mechanically or thermally.
- Wetlaid nonwovens have their origin based on paper-making. Fibers are dispersed in a dilute solution of water, surfactants, binders, and additives. They are agitated to separate fibers and disperse them uniformly onto a porous belt to form a web and then they are dried and bonded either chemically, mechanically or thermally.

Direct laid are either spunbond or meltblown:

- Spunbond nonwovens are made in one continuous process. Polymer pellets are melted and filtered. Fibers are spun, extruded drawn and quenched by cold air. Continuous oriented filaments are formed and deposited onto a moving screen and then directly dispersed into a web. This technique leads to faster belt speeds and lower costs. Bonding is by either chemical or thermal means.
- Meltblown is similar to the spunbond process but the polymers are melted, extruded and passed through a die where they are attenuated by hot air, thereby forming microfilaments. The filaments are still hot and tacky when they are collected in the web form. Consequently, the filaments self-bond, which eliminates the need for additional bonding.

Total nonwoven production was down 3.5% for 2008 for a total of 6.7 million tons. However, investments in spunlaid nonwovens equipment provided an increase of 150,000 tons capacity during 2008. Spunlaid equipment efficiency justified this growth. The US did experience some nonwoven plant closures, but significantly fewer than for textiles. Demonstration of the nonwoven production growth is indicative of the fact that spunlaid nonwovens handled the economic downturn by achieving a 4.0% growth and only carding dropped by 2.0%.

A variety of niche marketing opportunities are available as many markets for nonwovens are receptive to new products. Disposable markets accounted for the majority of nonwoven demand with a 64% share. Disposable consumer products, primarily baby diapers, adult incontinence, feminine hygiene products and wipes, represent the largest market for nonwovens. However, the filtration market, driven by regulatory changes and consumer concerns about air and water quality, is forecasted to see the strongest gains among disposable markets through 2012.

In 2012, demand for wipes is anticipated to be $500 million and $2.1 billion for China and US, respectively. Wipes growth is forecasted to be nearly 3%-4% per year. The US, Western Europe and Japan account for 72% of demand.

US demand in the total nonwoven roll goods market is projected to increase 4.5% per year to $6.1 billion in 2012. Driving factors include markets such as baby wipes, personal care wipes, consumer disposables, filtration units, non-disposables and construction applications. Further growth will come from increased market penetration in many applications including industrial wipes and roofing membranes and as new technologies improve the functionality of nonwovens.

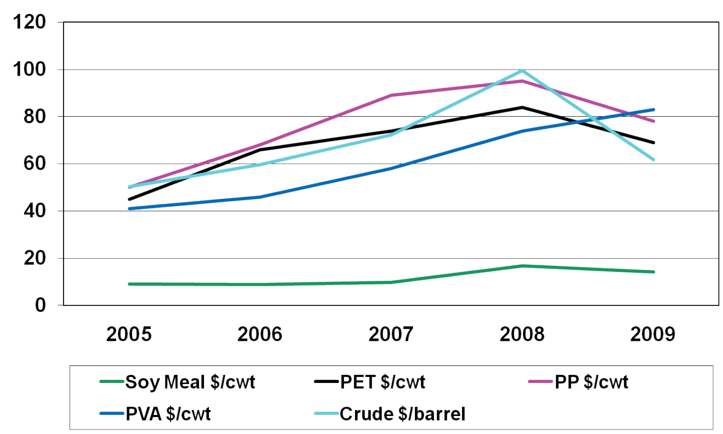
US Wipe Demand
Million $

	2003	2008	2013
Baby	412	518	560
Industrial	237	318	380
Disinfectant	137	213	290
Medicated	104	138	290
Moist Towels	71	96	115
Other	354	577	745
Total	1315	1860	2255

The non-disposable markets account for approximately one-third of nonwovens sales in 2009. Future growth is anticipated to be slower than disposables. However, construction non-disposable uses are the largest. This market is expected to post above-average gains from growth in non-residential construction. Other smaller markets, such as agriculture, will also see excellent new applications as nonwoven products continue to be developed. Declines in clothing and furniture will limit overall growth in the non-disposable segment as manufacturing of these products continues to move outside the US.

Pricing
Many everyday products depend on a stable and inexpensive supply of oil. The increasing crude oil prices in the international market have had an adverse impact on industries worldwide. Polypropylene, nylon, polyester and the other synthetic polymer raw material prices are tied to oil prices, which have risen considerably. Thus, the increasing raw material prices have pulled the textile and nonwoven prices with them.

Polymer Resin Feedstock Prices
2005 – 2009



Polymer Resin Feedstock
Dollars per Pound

	2005	2006	2007	2008	2009
PET	$0.45	$0.66	$0.74	$0.84	$0.69
PP	$0.50	$0.68	$0.89	$0.95	$0.78
PE	$0.43	$0.50	$0.56		
LLDPE			$0.80	$0.88	$0.66
PVA	$0.41	$0.46	$0.58	$0.74	$0.83
Nylon 6			$1.61	$1.63	$1.43
Nylon 6.6			$1.63	$1.72	$1.55
PAN	$0.60	$0.59	$0.82	$0.85	$0.70
Soy meal	$0.09	$0.09	$0.10	$0.17	$0.14

Fiber Pricing
Dollars per Pound

	2005	2006	2007	2008	2009
Cotton	$0.55	$0.59	$0.65	$0.72	$0.60
PET fiber-POY	$0.86	$1.03	$0.97	$1.37	$1.37
PET-textured	$1.22	$1.30	$1.30	$1.30	$1.30
Acrylic	$1.68	$1.69	$1.78	$1.81	$2.43
Rayon	$2.00	$2.08	$2.22	$2.37	$2.43
Nylon	$2.80	$2.87	$2.86	$3.14	$3.14
PET staple	$0.65	$0.72	$0.73	$0.92	$0.92
Acrylic staple	$0.86	$0.87	$0.87	$0.87	$0.87
Rayon staple	$1.08	$1.10	$1.10	$1.10	$1.10

Implications for Soybean Protein

Almost all fiber types, product lines and manufacturers globally have suffered from the slowing economy. Fibers like polyester, polypropylene, and acrylic were all down in volumes by 4.5%. Cotton, wool and silk also were down by approximately 10%. Cellulosics had been growing at a 3.5% rate, but recently dropped by 9.1%. Polyester staple is a major price driver. Other natural fibers have experienced a stagnant demand. Acetate filter tow for cigarette filters, however, did post a rise at 2.1% with average raw materials costing $0.60-$0.70 per pound and tow selling at $2.25 per pound. The new-age Lyocell products have done better than other cellulosics and are experiencing growth.

Natural fibers have a wide range of uses from high-priced apparel to industrial uses. They are important in nonwovens, home textiles and clothing. They are competing well against synthetics. The textile industry will adopt more sustainable processes slowly. Transformation is underway in the global supply chain. Other organic alternatives include wool ($4.18 per pound), bamboo ($2.10 per pound) and milk ($10.30 per pound).

The current Azlon fibers from China compete only in the clothing and craft yarn markets. They are priced too high for the mainstream textile and nonwovens markets. The current Azlon fiber is sold in filament and staple forms. It is a blend of soy protein isolate and polyvinyl alcohol. Market strategy focuses on the product being green and sustainable, having the softness of cashmere, the luster of silk, perfect ventilation, being the sole botanic protein fiber in the world, containing 18 amino acids, beneficial to the human body and containing added bacterial protection.

The new fibers being developed using soy proteins are expected to compete with many of the natural and synthetic polymers. Development is focused on achieving a competitive product for performance, quality and economics. Fiber properties achieved will define target applications. Staple textile and nonwoven applications are the initial target markets.

While soy meal averaged about $0.14 per pound in 2009, it is encouraging to note, unlike other commodity prices or petrochemicals that were rising in early 2010, the price of soy meal was decreasing in early 2010, as textiles will need to use the least expensive, yet functional, amount of soy-based protein possible to compete. Should the need be for soy flour, although the protein content will be 50%, the cost will be $0.18-0.20 per pound bulk. Should the textile require an alcohol washed soy concentrate with 69%-70% protein, that cost could be in the range of $0.65-$0.72 per pound. Or should greater functionality be required, the soy concentrate could cost $0.85-$1.25 per pound. Lastly, should soy protein isolate (90+% protein) be necessary to achieve functionality, that cost could be anywhere from $1.50-$2.25 per pound.

SECTION 8 OTHER MARKETS

8.1 MOSQUITO CONTROL LARVICIDES

In the past, Mosquito Control Districts in the United States typically used adulticides to control adult population of mosquitoes in urban areas and in areas where intensive animal agriculture was practiced. Today, pesticide-sensitive urban and rural communities demand more innovative approaches to mosquito control that result in less exposure to pesticides for both human and animal populations. The public is now favoring the use of control measures that focus on larval control rather than adult mosquito control. The basis in pest control theory for this approach is three-fold. First, larval populations are more concentrated than adult populations, thus providing easier control. Secondly, larval populations have very little mobility compared to adult populations, thus again providing easier control. And thirdly, control of the larval stage is strategically smarter, because the adult stage is the only stage that transmits disease. Hence, Mosquito Control Districts throughout the United States are employing new biological and chemical methods that involve the use of bacterial larvicides, monomolecular films and methoprene briquettes, all of which are expensive. The use of petroleum-based oils has been an alternative, especially in rural areas. However, with the increasing costs associated with petroleum-based products, there is increasing interest in biobased products with reduced costs, equivalent effective control and greatly reduced non-target toxicity.

The rapid spread of newly introduced mosquito-borne diseases has provided an immediate opportunity to develop and market a highly effective biobased larvicide. For example, since 1996, West Nile virus (WNV) has spread across the United States and into Mexico and Canada. Although certain bird species are the carrier of the disease, it is the adult mosquito that transmits the virus to humans and such animals as horses. In the Western United States, more than 100,000 coalbed methane ponds are now breeding grounds for the recent spread of West Nile virus by the mosquito *Culex tarsalis*. Mosquito districts and the coal and gas industry have realized the need for more cost-effective and safe larvicides. This provides an immediate opportunity to develop and market a soy-based larvicide. Moreover, the introduction of an efficacious, environmentally safe and cost-effective soy-based larvicide could create broader market opportunities in addressing the worldwide need to prevent such diseases as West Nile virus, Dengue Fever and malaria. The key to the success for control of malaria is adequate surface persistence, since most oil-based larvicides readily decompose in sunlight and high temperatures.

Supply and Demand

Annual US mosquito abatement expenditures are now estimated to be about $120 million, with $50 million for larvicides, $60 million for adulticides and $10 million for pupacides. This compares to 1994 total expenditures by abatement districts of $27 million, with about $1 million for larvicides.

Competing Products

Conventional larvicide products are typically based on highly refined paraffinic mineral oils containing an active toxicant, such as a pyrethroid or bacterial pesticide. Competing brands are:

- BVA Larv2 from BVA, Inc.
- Bonide from Bonide Products, Inc.
- Golden Bear 1111 from TRICOR Refining LLC/Clarke Mosquito Control

These "surface oil" larvicide products contain petroleum distillate mineral oils that can be toxic to fish and other aquatic life. Mineral oil pricing has nearly tripled since 2005.

The soy-based larvicide product formulation BIO-LARV that has been developed jointly by BVA Oils and Stepan Company, through a project supported by the United Soybean Board, is an emulsifiable concentrate containing 93% methyl soyate and 7% inert ingredients.

The advantages of a methyl soyate-based larvicide over mineral-oil-based products include longer residual activity, lower VOCs, lower flammability, lower toxicity and better biodegradability. The current formulation has demonstrated excellent larvae control within 24 hours (>98%), and initial persistence studies have confirmed a continuing effectiveness after one month. It has also demonstrated essentially no impact on non-target organisms, and other aquatic organisms, such as frogs or fish.

Pricing Trends

Larvicide feedstock costs and market pricing have escalated rapidly with rising petroleum feedstock prices.

Feedstock Costs and Market Pricing
Dollars per Gallon

	2005	**2006**	**2007**	**2008**	**2009**
White Mineral Oil (Group II)	2.80	3.13	3.50	5.20	8.00
BVA Larv 2	7.00	7.50	8.00	9.00	12.50
Methyl Soyate	4.40	4.50	5.10	7.00	6.80

Implications for Soybean Oil

The use of methyl soyate as the carrier solvent and active ingredient (as a suffocant) in a mosquito larvicide to control West Nile virus and, potentially, malaria should provide many advantages over conventional mineral-oil-based larvicides. Ground and aerial field-testing have demonstrated a high larva kill rate performance with acceptable persistence. Current product cost now favors the marketing of the soy larvicide. The field data collected in 2009 suggests that in most habitats harboring mosquito larvae, an application rate of 3 gallons per acre will be cost-effective and competitive. The soy-based larvicide should be able to replace the conventional mineral-oil-based larvicides and create a significant new mosquito control market opportunity.

CHANGES SINCE 2008

The presence of the mosquito-borne diseases, including West Nile virus, continues to drive the US mosquito control industry. Abatement product expenditures have doubled since December 2005 with much greater use of larvicides. Severe solvent feedstock cost escalation has strongly impacted these products, especially mineral oils (up >250%), the major component of all conventional "surface oil" larvicides. Unfortunately, as the prices have escalated for the cost of mosquito control products, Federal, State and County funding provided to Mosquito Control Districts has remained level.

The public's attitude toward pest control now favors the use a "green" product. The public views soybeans as a source of healthful food products, and if soybean oil can be converted to a biobased larvicide that is environmentally safe, efficacious and economical, this will be viewed as an opportunity for purchase by Mosquito Control Districts.

8.2 GLYCERIN

Glycerin is generated as a co-product during the conversion of vegetable oils and tallow to fatty acids and methyl esters. The production of soaps, fatty acids and biodiesel are the main sources of natural refined and crude glycerin.

Primary end-use applications for glycerin are oral care products (toothpaste, mouthwash), skin and hair care products, food and beverages, urethane polyols, pharmaceuticals and tobacco. Extensive research is underway to develop new uses for glycerin, including conversion to industrial chemicals such as propylene glycol and epichlorohydrin.

SUPPLY, DEMAND AND CHANGES FROM 2008

Glycerin has been a mature chemical commodity with a very stable supply/demand balance, with most of its supply generated as a co-product from the production of soap derived from animal fats. The introduction of biodiesel to the US chemical industry, however, upset this historic glycerin industry balance. Since the end of 2005, production of biodiesel in the US has exploded from 75 million gallons to 690 million gallons in 2008, then dropped to 450 million gallons in 2009 due to a number of factors, including the economic slowdown. The supply of crude glycerin, a 10% co-product of biodiesel, also dropped. Concurrently, biodiesel production in Asia also took off, joining Europe, an established biodiesel market, in producing excess crude glycerin.

The result was a world glut of glycerin supply that quickly caused market price erosion and convinced Dow Chemical to exit the domestic glycerin business by closing the only US synthetic glycerin plant in early 2006. Glycerin market pricing, predictably, dropped quickly, bottoming out in late 2006 and then escalating in response to the rapid rise in hydrocarbon and seed oil prices throughout 2007. Prices continued to increase during the first half of 2008 and then began to decline. During the fourth quarter of 2008, prices of refined glycerin dropped again from the mid-$0.80 per pound range to the mid-$0.50 per pound range. Prices continued to drop in early 2009 to the low of $0.40 per pound. This drop in prices was largely due to a supply/demand imbalance caused by the global economic recession and the excess production of biodiesel, which continued into the third quarter of 2009 before production was shut down in the US.

Current capacity of by-product glycerin from biodiesel production plants is 2.12 billion pounds at full biodiesel production capacity. Biodiesel production capacity utilization declined substantially in 2009 to 450 million gallons, and with it, the production of by-product crude glycerin fell from 563 million pounds in 2008 to 367 million pounds in 2009. Due to the delay by the Federal government to renew the biodiesel blending credit, which has caused many biodiesel operations to shut down, supplies of glycerin are currently tightening with a concurrent rise in prices.

The US market demand for glycerin has been about 460 million pounds per year, but dropped markedly in the 2009 recession. Commercial success of new glycerin-based chemical intermediate processes, such as ADM’s new crude glycerin to propylene glycol plant, and new market applications should stimulate long-term demand growth. In the meantime, biodiesel production in the US, Europe and Asia will fluctuate depending on the price of petroleum-based diesel, trade issues (especially in Europe) and government mandates regarding the use of biodiesel. These fluctuations could result in an unstable balance between glycerin supply and demand as well as cyclic pricing.

Feedstock Pricing

Glycerin market pricing today is determined by supply/demand balances and the pricing of seed oils: US – soybean, Europe – rapeseed, and Asia – palm. The rapid world growth of biodiesel production created a large supply glut of co-product crude glycerin, which eroded natural/refined glycerin pricing through 2006.

In 2007, however, glycerin supply began to decline rapidly due to the impact of escalating prices of seed oils. This happened immediately following the loss of Dow's 140 million pounds of synthetic glycerin production in early 2006.

GLYCERIN PRICING (Year End)**
Cents per Pound

	2001	2002	2003	2004	2005	2006	2007	2008	2009
Natural (Refined)	60	58	65	55	45	35	70.5	55	41
Synthetic	72	73	90	85	85	*	---	---	---
Crude	15	12	12	10	5	2	10	5	6

*Dow closed 140 million pound synthetic glycerin plant early 2006
**Various sources

Through mid-2008, excess crude glycerin stocks declined and the market price for glycerin escalated in response to the record high price levels for all seed oils and derivatives. Market demand for glycerin, however, stayed quite stable through most of 2008, then dropped in November as recession set in. Through 2009, glycerin demand declined 9%-10% from a year earlier, and inventories were depleted through the third quarter to reduce costs. With the beginning of 2010, demand has gradually grown to rebuild working inventory levels and response to an improving economy.

The global availability of low-cost, co-product crude glycerin in recent years has had a moderating influence on glycerin market pricing and motivated many end-users to look at opportunities to substitute glycerin for other polyhydric alcohols, such as propylene glycol and sorbitol, to reduce costs. Numerous new uses for glycerin and processes that can utilize crude glycerin are in development but not yet commercial.

Recessionary pressures in 2009 and the delay in the US Senate to act on renewal of the biodiesel tax subsidy has shut down most biodiesel production in the US and with it, crude glycerin production. As of March 18, 2010, the US House of Representatives has approved a bill allowing the biodiesel tax incentive to be renewed. Should this Bill proceed through

Congress, it should set the stage for a restart of biodiesel plants and increase the availability of crude glycerin.

8.3 TRANSFORMER DIELECTRIC FLUID

Transformer oils serve the dual role of coolant and insulator in utility and industrial electrical equipment. The oils, or fluids, must withstand the electrical stress of tens of thousands of volts, be thermally stable and compatible with transformer materials of construction

The market for dielectric transformer oils is segmented into initial fills and retro-fills. The dielectric fluid initial fill comprises approximately 4% to 8% of the purchase cost of voltage regulator and distribution equipment. The cost of the fluid is typically amortized over a long period and thus is a modest portion of the overall cost of electrical service. The typical life expectancy of an electrical transformer is estimated at 20 years.

Retro-fills may be required due to losses caused by damage from lightening strikes and leakage/volatilization of fluids or degradation of insulating components over time. Losses due to accidental transformer impact may require retro-fill and bio-remediation, which is driving the market toward more environmentally sensitive fluids in both initial fills and retro-fills.

Traditionally, refined naphthenic (petroleum) oils have been the leading oils used in transformers due to their low cost, fluidity and ease of purification. However, the relatively low flash point (145º C) of naphthenic oils makes them unsuitable for locations where flammability is a concern (next to or inside buildings). Silicone oils, soy, synthetic esters and high molecular weight hydrocarbons have been used where the need for low flammability offsets their significantly higher cost.

Increasingly, soy-based transformer fluids are displacing other fluids in both initial fills and retro-fills. The soy fluids offer an improved life cycle cost due to lower environmental impact, easier bioremediation, extended paper insulation life and better fire safety (flash points >300º C). Further, it is estimated that petroleum-filled transformers have over 50 times greater carbon emissions than soy-filled transformers over a 30 year operating life.

Supply And Demand

The North American market for dielectric transformer fluids for electrical distribution is in the range of 60 million gallons per year, including initial fills and retro-fills of existing transformers. The market has primarily used naphthenic mineral oil products as the cyclic content provides the low pour point. These naphthenic oils are derived from naphtha, which is the first “cut” or lightest fraction of petroleum refining. Demand for naphtha for production of other chemicals such as benzene, toluene and xylene has increased, putting pressure on supplies of naphtha for refining into naphthenic oils and mineral spirits. Transformer oils may account for about one-third of the US naphthenic oil demand.

Pricing

Current price for fully formulated soy-based transformer dielectric fluid is reportedly in the range of $10.00 per gallon, compared with approximately $3.75 per gallon for the widely-used naphthenic mineral oil product and approximately $15.00 per gallon for silicon-based dielectric fluids. The industry indexes the price of naphthenic oils to mineral oil at West Texas Intermediate (WTI) crude price per barrel plus an adder and, thus prices are expected to follow the general lubricant pricing trends already described. Soy transformer fluids are indexed to the Chicago Board of Trade (CBOT) soybean oil price index.

Implications for Soybean Oil

Use of natural ester oils began receiving serious attention in the early 1990s due to the poor biodegradability and associated cleanup costs of mineral oils.

Today, the transformer life is extended substantially (as much as doubled with up to eight times slower aging of the cellulose insulation) with soy versus mineral oils. Further, soy fluids have better fire safety (high flash points), a significantly better environmental impact profile, better worker safety and may incur lower clean-up and disposal costs. While the soy-filled transformers are approximately 10% higher in cost than petroleum-filled transformers, the total life cycle cost due to these factors is expected to significantly outweigh the initial purchase cost difference.

It is reported that there has been a high demand for the soy-based environmentally friendly product in the replacement of distribution transformers destroyed by wind and flood in recent hurricane seasons. Future relative increases in petroleum-based mineral oil price would make the soy-based product increasingly cost-effective.

Regarding oxidative stability, distribution transformers in service in North America are sealed units, thus providing an essentially oxygen-free closed system for the dielectric fluid. In Europe, transformers are vented to the atmosphere and the current soy-based product cannot now be recommended for such service.

CHANGES SINCE DECEMBER 2008

The overall transformer oil market declined about 20% from 75 million gallons in 2008 to 60 million gallons projected in 2010, due primarily to the decline in housing starts. Soy fluids, however, are gaining significant market share with volume growth of about 20% per year. Cooper Power reports that more than 250,000 soy utility transformers are now in operation in the US, with the addition of about 50,000 per year.

8.4 SURFACTANTS

Surfactants or surface active agents are broadly defined as organic compounds that can enhance cleaning efficiency, emulsifying, wetting, dispersing, solvency, foaming/de-foaming, and lubricity of water-based compositions.

Supply and Demand

The annual surfactant demand in the United States is estimated to be 7.7 billion pounds. The largest end-use market for surfactants is household cleaning detergents. These are comprised of large volume, lower priced laundry and dishwashing detergent commodity products that account for roughly one-half of the US surfactant market. “Specialty surfactants” are higher-priced, low-volume products used in a broad range of industrial and personal care market applications, with annual demand estimated at 2 billion pounds or 26% of the total US surfactant market.

Pricing

Surfactants are produced from petrochemical (synthetic) feedstocks or oleochemical (natural) feedstocks. The US surfactant production is based on 40% petrochemical and 60% oleochemical feedstocks. The basic petrochemical feedstocks are ethylene and benzene, which are derived from crude oil and converted to surfactant intermediates ethylene oxide (EO), linear Alkylbenzene (LAB), and detergent alcohols. The basic oleochemical feedstocks are typical seed oils – palm and coconut – as well as tallow. Raw material costs for these feedstocks are a prime determinant of surfactant pricing. Linear alcohols containing 12 carbon atoms (dodecyl alcohol or lauryl alcohol) are primarily used in synthetic detergents. The average contract price range for these alcohols is in the mid-$0.85 per pound range.

Implications for Soybean Oil

It is difficult to estimate the amount of soy-based surfactants being produced because of the supply chain complexity. The largest volume of soy-based surfactants is represented by lecithin. Soybean oil and soy protein are used as the starting materials for surfactants; however, soybean oil is currently the predominate feedstock used in the manufacture of surfactants where soybeans are used. Unfortunately, soybean oil contains mostly C18 fatty acids that have solubility and aquatic toxicity issues, where the lower length carbon chains of palm oil and coconut oil do not have these problems.

Increasing environmental awareness and the use of renewable resources provide opportunities for the use of soybeans in surfactants through new technologies that are emerging, especially in the field of protein-based surfactants.