

The background is a blue-tinted industrial scene featuring various pipes, tanks, and structures. A large white compass rose is overlaid on the right side of the image. The text is positioned in the upper left quadrant.

Securing Hot Melt Supply: Navigating the New Landscape of Adhesives Raw Materials

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A new business reality has emerged from the economic crisis. New trends are now challenging the pre-recession status quo. The adhesives industry is not immune to this shifting landscape. Hot melt adhesives, in particular, are being hard hit. Supply threats, both novel and resurgent, are altering the framework of hot melt adhesives' raw materials supply. The supply of waxes, rubbers, tackifiers and ethylene vinyl acetate (EVA) is affected.

Broad trends—rising oil prices related to upheaval in the Middle East and unexpected supply chain disruption caused by the recent earthquake, tsunami, and nuclear crisis in Japan—are changing the way business is being done around the world. Many industries are struggling to navigate this new reality. Forecasting oil prices is difficult at the best of times. Inject regional rebellions against entrenched leaders and rampant market speculation, and volatility becomes the norm. Meanwhile, the Japanese crisis is forcing businesses to reevaluate a treasured and, until now, highly efficient supply chain practice: Just-in-time may no longer be good enough.

Other trends, like the unforeseen boom in shale gas exploration in the United States, offer lucrative growth opportunities to some sectors but are having serious repercussions for others. In particular, the abundance of low-cost shale gas feeds available to North American olefins crackers is changing the mix of products coming out of crackers. By choosing low-cost natural gas feeds instead of higher-cost feeds from crude oil, cracker operators effectively reduce the production of feedstocks used to make hot melt raw materials. Because there are no immediate alternatives to petroleum refining to produce these feedstocks, the industry must contend with a future of constricted supply and higher costs.

Moving farther down the supply chain to specific raw materials used in hot melt adhesives, a complex interplay of supply, demand, fierce competition, and rising costs is buffeting many raw material streams. From weather-challenged rubber harvests in Asia to a surging photovoltaic industry that requires ever greater volumes of EVA for solar encapsulants, the threats to supply are coming from many possibly surprising directions.

This dynamic—broader business trends overlaid with raw material-specific supply threats—is creating an increasingly challenging supply environment for hot melt adhesives. It is forcing adhesives manufacturers to compete more intensely with other industries for limited supply, often by paying higher premiums to secure it. The situation isn't expected to improve anytime soon. Understanding this emerging landscape of adhesives raw materials supply will help adhesives customers better plan for the potential disruptions and certain rising costs that are looming on the horizon.

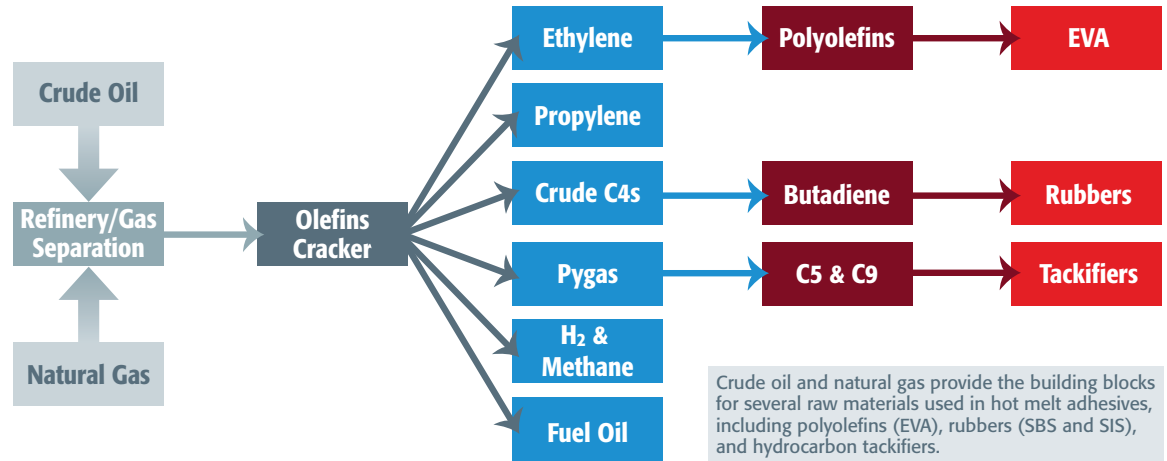
Broad Trends: Oil Price Inflation

Petroleum underpins the modern world. Not only does it fuel industry and commerce, but it also forms the basis of a vast array of industrial and consumer goods, including adhesives. Many key raw materials used in the formulation of hot melt adhesives are produced by the refining and processing of crude oil and natural gas. Emerging trends affecting the refining and petrochemical industries, therefore, have a profound impact on the supply and cost of these adhesives raw materials.

Crude oil prices hovered between \$70 and \$80 per barrel for most of 2010. In the recent past, this price level appeared to be a sweet spot for markets. OPEC producers were generally happy with the returns generated by \$80 per barrel crude. According to Purvin & Gertz CEO Bill Sanderson, speaking at a March 2011 Chemical Market Associates Inc. (CMAI) conference in Houston, this price was also high enough to spur development of nontraditional oil sources such as the Canadian oil sands, yet not so high that it had a negative impact on demand.¹ The situation may now be changing.

¹ CMAI. (2011, March). Twenty-sixth Annual World Petrochemical Conference. Houston, Texas.

FIGURE 1:
FROM PETROLEUM TO HOT MELT RAW MATERIALS



As a wave of unrest flowed through the Middle East and North Africa in the fall of 2010, global crude prices moved higher. The price of West Texas Intermediate (WTI), the North American benchmark, passed the \$100 per barrel mark in early March and has been holding steady above this elevated level as the upheaval continues.

Energy markets have always reacted to geopolitical risk. However, the dramatic recent events in the Middle East and North Africa have added another layer of complexity to the picture. In such a volatile situation, analysts are forced to revise forecasts on an almost daily basis as they interpret unfolding events.

Market sentiment, expressed in futures trading, is betting on higher prices. Purvin & Gertz's Mr. Sanderson believes that the world will continue to experience \$100+ per barrel oil for a sustained period. CMAI's latest global economy and energy markets forecast uses \$95 per barrel oil as a base case and explores scenarios ranging from \$115 to \$135 and even \$150 per barrel crude.² Tellingly, there are no scenarios for lower-priced crude in the consultancy's forecast.

In fact, moves made by Saudi Arabia to avoid the spread of unrest may support higher long-term pricing. The kingdom has earmarked a \$150 billion infusion for social programs and subsidies in a strategy meant to appease its younger population and ward off unrest. Analyst Rachel Ziemba from Roubini Global Economics in London told *Bloomberg Businessweek* in April that the kingdom now requires oil prices of \$85 to \$90 to pay for its programs and balance its budget, up from \$25 in 2003.³ This means that the Saudis will be unwilling to pump extra oil to moderate global supply and prices, especially if prices again drop below this higher level.

All these factors translate into an inflationary environment for adhesives raw materials. Rising energy prices inject pressure throughout the adhesives supply chain, inflating the cost of feedstocks used to formulate hot melt raw materials and increasing the cost of transportation and manufacturing.

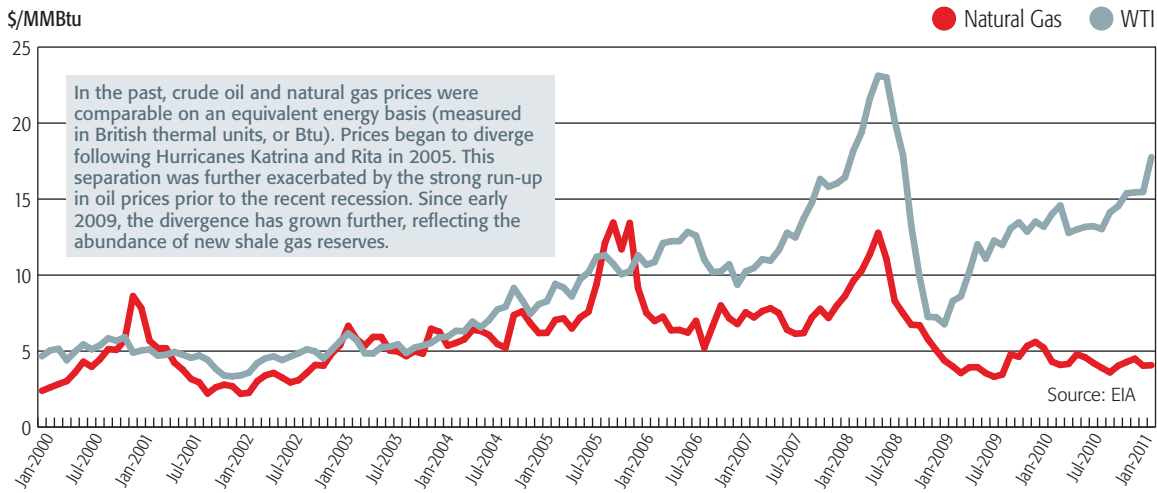
There is a hidden toll as well. While oil prices have climbed in recent years, the discovery of abundant new reserves of domestic natural gas has driven down natural gas prices. This has resulted in a dramatic, and some say permanent, divergence between the costs of these two energy sources. This is improving the future of the North American petrochemical industry but also increasing the supply threat for hot melt raw materials.

² CMAI. (2011, March). Twenty-sixth Annual World Petrochemical Conference. Houston, Texas.

³ Stanley Reed, Mark Shenk & Grant Smith. (2011, April 7). Oil Traders See Lasting Mideast Instability. *Bloomberg Businessweek*: http://www.businessweek.com/magazine/content/11_16/b4224008425622.htm.



FIGURE 2:
CRUDE OIL/NATURAL GAS DIVERGENCE



Broad Trends: Japan Revolutionizing the Supply Chain—Again

Japan's largest car company, Toyota, revolutionized global supply chain practices by sharing the cost benefits of its just-in-time supply chain with the world. Over the past two decades, the concept of keeping inventories lean and having supplies delivered at the last minute has spread throughout the global manufacturing chain. Now, events in Japan may once again change the way that manufacturers manage their supply chains. Lean, just-in-time methods may be forced to evolve to include just-in-case alternatives.

In North America, the efficacy of just-in-time inventory practices took a hit in 2005 when Hurricanes Katrina and Rita devastated the U.S. Gulf Coast, home to the bulk of the North American petrochemical industry. The shutdown of offshore drilling platforms and onshore refineries and petrochemical plants paralyzed an entire segment of the supply chain. This marked a turning point for North American supply chains—and especially for those in the adhesives industry. In the aftermath of these supply interruptions, managers were forced to take a much closer look at the security of their supply chains.

Managers shifted their focus to diversify supply chains geographically and develop a better understanding of upstream connections—learning who supplied their suppliers. This movement has advanced further in recent years, driven by efforts to “green” the supply chain, which is forcing all industries to closely examine their supply chains. The economic recession also played a role, when the financial health of suppliers, their suppliers, and even those farther up the chain all came under intense scrutiny.

Adhesives companies were restrained in their ability to diversify, however, by the restricted number of suppliers producing the raw materials they needed. The hot melts chain, characterized by a limited number of players and low-volume specialty raw materials, was especially constrained.

The adhesives raw materials supply pool grew even smaller during the downturn as suppliers reevaluated product portfolios and exited underperforming markets. Now, a wave of mergers and acquisitions in the petrochemical industry threatens further erosion of the supply base.

As a result, many adhesives companies have already shifted away from just-in-time practices ever so slightly and are carrying greater raw material inventory in an effort to mitigate supply shocks. At the same time, ongoing cost-cutting programs implemented during the recession are putting pressure on procurement professionals to

barter the risk mitigation of a diversified supply base for the cost reduction that can come with placing larger volumes with a single supplier. The trade-offs—increased diversity versus greater cost savings, larger inventory carrying costs versus greater exposure to supply disruptions—have resulted in increasingly complex calculations for adhesives companies in recent years. The line between secure supply and acceptable costs is growing razor-thin.

After Japan's disaster, the global supply chain is poised to change again. One of the biggest surprises to emerge thus far was the network of supply chain connections and vulnerabilities unearthed by the crisis.

“Even though ... Japan's quake is unlikely to cause lasting damage to regional production, the scare could nonetheless hasten the realization that a supply chain that is lean and cost-friendly is also rather taut and potentially subjected to unforeseen disruptions along its stretch,” wrote economists Wellian Wiranto and Frederic Neumann in an HSBC report.⁴ “This could result in an even more substantial hit to the bottom line should the whole production pipeline essentially become hostage to any severe cutback in one or two nodes of the chain.” As a result, companies may once again seek to diversify suppliers—just in case.

Where this trend is likely to play out is in enhanced competition for available supply as companies jockey to secure greater volumes and build inventory cushions. Aggravating this problem is the already extremely tight supply chain for many hot melt raw materials. In many cases, there is no additional material to be had—at any price.

In addition, upstream producers continue the selective pruning of their least profitable customers, a group that often includes adhesives customers, leaving these companies scrambling to secure supply elsewhere. As competition for available supply intensifies, costs will migrate higher.

In the aftermath of the Japanese disaster, global manufacturing supply chains may indeed be retooled to increase resistance against supply shocks. This insurance will come at a cost, though. In the case of hot melt adhesives raw materials, the supply chain will be as vulnerable as ever, if not more so. Everything points to a dwindling number of suppliers wielding ever-greater pricing power, intensifying competition and raising costs.

The Shale Gas Revolution: Impact on Adhesives Raw Materials

The term “fracking” has gained common currency in the North American vernacular. To some, the method it describes is the key to future prosperity. To others, it is a denigration of the environment. Regardless of the interpretation, the boom in natural gas deposits locked within shale layers below the surface of the American heartland has become big news. For better or for worse, shale gas is here to stay.

These deposits are neither new—geologically, they're quite old—nor unknown; oil companies have been aware of their existence for years. Until recent advances in technology, however, there wasn't an economical way to extract the gas. Now, engineers have unlocked the riddle of efficient shale gas extraction. Emerging technologies that include hydraulic fracturing (“fracking”), which injects water, sand, and a cocktail of chemicals into the ground to fracture rocks and extract gas, have changed the economics of shale gas.

In fact, the companies that are exploring these gas-rich basins are getting more efficient with each passing month, Alan Armstrong, CEO of Williams, told participants at the March CMAI conference in Houston. “It's truly a revolution, and it's not over yet; we're still getting better at extracting these resources,” he said.

As the costs of developing these shale gas resources drop, extracting larger swaths of shale gas becomes economically feasible. This evolution in technology has led to a dramatic increase in gas reserves. The country now has enough gas to satisfy current demand levels for 100 years. What's more, consultants and natural gas players agree that even that figure is extremely conservative.

⁴ Wellian Wiranto & Frederic Neumann. (2011, March 24). Hype, not Fact: No Need to Fear a Japanese Supply Crunch. HSBC Global Research: <http://www.research.hsbc.com/midas/Res/RDV?p=pdf&key=GJGfXNK0m0&n=294230.PDF>



In 2008, the production of natural gas from shale accounted for roughly 11% of total natural gas production, CMAI said in a recent report.⁵ By 2010, shale gas production had increased to 23%. The U.S. Energy Information Administration (EIA) expects this figure to reach 45% by 2035.⁶

The petrochemical industry may become one of the largest beneficiaries of this growing supply of inexpensive gas. CMAI says the renaissance of the U.S. industry could lead to the construction of new North American ethylene crackers. In fact, in the second quarter of 2011 several major chemical companies announced plans to build new olefins crackers in North America.⁷ Mr. Armstrong expects that North American cracking capacity will grow 10% in the next five years. The advantaged feedstocks would also position North America as a low-cost producer for years to come and could lead to a booming export industry.

Market movers: refining's Goliath to adhesives' David

The North American refining industry is in the business of producing heating and transportation fuels. Only 7% of the crude oil that is refined is destined for the petrochemical industry, which must purchase components out of the refining stream. In the case of natural gas, only 2% of what is processed goes into petrochemicals.⁸ This means that the fuel oils industry sets the value of the market and the petrochemical industry is essentially along for the ride.

Within the petrochemical industry, ethylene and, increasingly, propylene are the market drivers. Global butadiene capacity is swamped by that of combined ethylene and propylene capacity. This means that the production of C4s and other heavy molecules is almost an afterthought to the larger industry. In addition, not all crackers have the capacity to process crude C4 output into butadiene. Issues of tight supply or rising costs of these by-products have little impact on refining and cracking decisions. As a result, the supply of C4s, butadiene, C5s, and C9s that are so critical to hot melt adhesives are at the mercy of much larger and more powerful market forces.

This has led many feedstock suppliers to change the way they set prices for their resin former customers, who then supply raw materials to the adhesives industry. Many feedstocks can remain in the refining stream to act as octane boosters in the production of gasoline. In the past, pricing was often dictated by a feed's alternative value as an octane booster in gasoline. These suppliers are now decoupling their pricing mechanisms from former price formulas to seek higher, market-driven price premiums.

Abundant natural gas moving cracking feeds lighter

The news that there is now an abundant source of low-cost natural gas is good for any business that relies on ethylene and its derivatives. It's not so good for the hot melt adhesives industry. The problem lies in the growing spread between rising crude oil prices and retreating natural gas prices, and the impact this has on cracker economics.

Most North American crackers are flexible, which means that they can run on a spectrum of feeds, ranging from heavy naphtha from crude oil to lighter ethane from natural gas. Before 2006, crackers only flexed, or varied, their feed by about 10% to 30% depending on feed costs, according to Tom Brewer, T.A. Brewer Consulting, Inc.⁹ By 2009, they could flex up to 70%. Today, cracker operators continue to retool plants, pushing them to accept greater volumes of lighter feeds.

Feedstock choice has a large impact on cracker margins. Morgan Stanley estimates that feedstock costs represent more than 80% of the operating expenses in the production of ethylene.¹⁰ Cracker operators use complex computer programs to fine-tune a mix of feeds, often weekly, to optimize the economics of their units. They

⁵ CMAI. (2011, March 31). *Economy and Energy Overview*, 11(3)

⁶ EIA. (2010, December 16). *Annual Energy Outlook 2011*: <http://www.eia.doe.gov/forecasts/aeo/>.

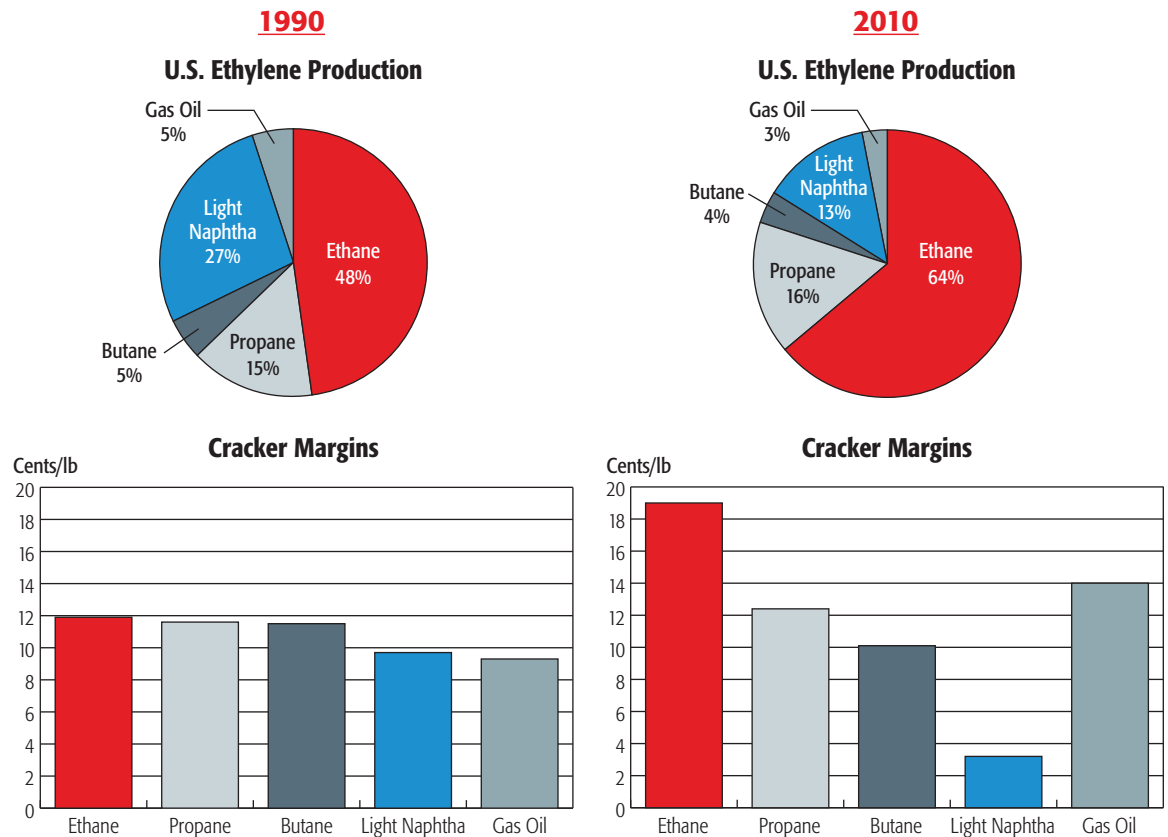
⁷ Vincent Valk. (2011, April 21). Dow to Build U.S. Ethylene, Propylene Plants. *ChemWeek*: http://www.chemweek.com/home/top_of_the_news/34306.html.

⁸ CMAI. (2011, March 22). *Petrochemical Industry Fundamentals Workbook*, 9.1.

⁹ Tom Brewer. (2011, February). Trends in Butadiene & SBS. Association of Modified Asphalt Producers 12th Annual Meeting: <http://amap.ctcandassociates.com/wp/wp-content/uploads/D-Brewer-Status-of-Global-Asphalt-supply.pdf>.

¹⁰ Paul Mann, et al. (2010, October 18). Petrochemicals: Preparing for a Supercycle. Morgan Stanley.

FIGURE 3:
CRACKER MARGINS DRIVE FEEDSTOCK CHOICE



Source: Entreprise Product Partners, CMAI Conference March 2011

In the past two decades, North American ethylene production from ethane has grown from 48% to 64%, while production from naphtha feeds has dropped from 27% to 13%. The divergence of cracker margins associated with the various feeds is driving the trend. In the current environment, ethane feeds deliver much higher margins than any alternative.

want to use the largest volume of low-cost feeds possible to produce the petrochemicals required by their customers.

As natural gas prices have dropped in recent years, flexible cracker operators have increasingly switched to ethane feeds. Since 2005, ethylene production from ethane has almost doubled, according to CMAI.

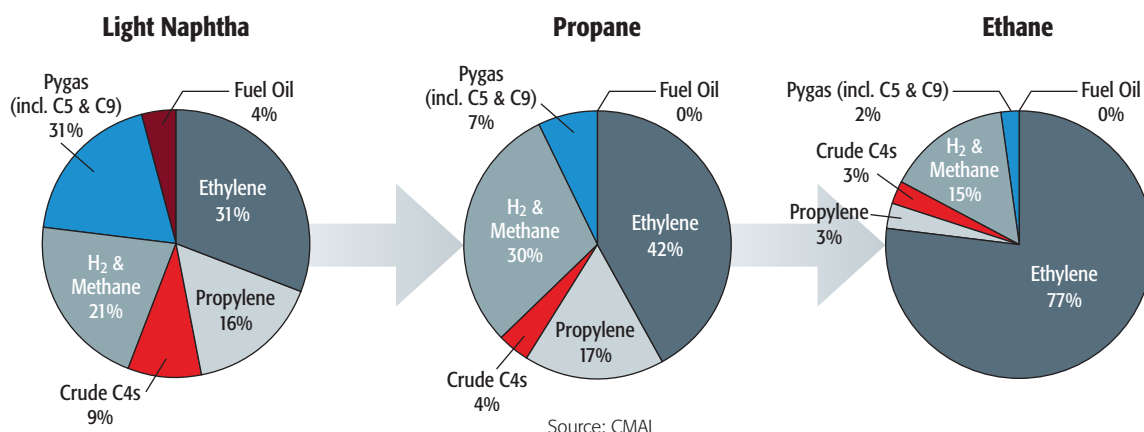
The problem for the adhesives industry is that as the cracker feeds get lighter, fewer co-products result. That means less propylene, C4s, and heavier molecules available for the production of hot melt raw materials. The effect is exacerbated for pyrolysis gasoline (pygas), the source of C5 and C9 compounds used in tackifiers. Cracking ethane reduces not only the quantity but also the composition of the pygas stream, producing less of the C5 and C9 compounds required by adhesives. In recent years, this has constricted the supply of many of the chemicals that are building blocks for hot melt raw materials, such as tackifiers and rubbers.

Global perspective

CMAI forecasts that the advantaged ethane situation of North America will continue to drive domestic producers to optimize crackers to run on lighter, cheaper natural gas-based feeds. This will continue to squeeze the domestic supply of critical hot melt feedstocks, including propylene, butadiene, C5s, and C9s. This could also force North American hot melt adhesives formulators to look overseas for supply.



FIGURE 4:
FEEDSTOCKS MAKE A DIFFERENCE



The drive to lighter cracking feeds improves margins, but at a cost. Propane cracking produces less than half the volume of crude C4s of naphtha cracking. Ethane produces a third. In addition, ethane cracking yields less than a tenth of the pygas of naphtha cracking.

While feeds are getting lighter around the world, the global impact on ethylene production is more muted. Heavy feeds still dominate ethylene production, accounting for about 50% of global production, compared to 32% for ethane, Mark Eramo, executive vice president of CMAI, told conference attendees in March. CMAI sees ethane-based production only growing to 35% of global markets by 2015.

The problem is that overseas naphtha crackers are at the high end of the cost curve, which means that margins are thin, and getting more so as global crude prices climb. Mr. Eramo said that the naphtha derivatives—C4s, butadiene, C5s, and C9s that are the precursors to hot melt raw materials—will have to continue to increase in price in coming years in order for that production to remain economically sustainable.

This has the potential to dramatically alter the supply chain. Producers in regions tied to naphtha, like Southeast Asia, may not be content to simply export C4 feeds or butadiene to North America. Instead, they may seek to improve margins by upgrading these into raw materials for the adhesives industry and other industries. This complicates the supply chain and inflates costs.

Specific Raw Material Supply Threats

The hot melt adhesives raw materials supply landscape is nothing if not complex. Every hot melt raw material is experiencing some form of supply disruption or supply/demand-related cost increase. Given this background, threats to four types of raw materials are especially critical: waxes, rubbers, tackifiers, and ethylene vinyl acetate (EVA).

Waxes

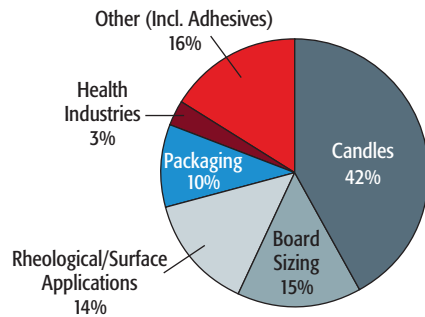
Wax supply has become chronically tight in recent years. Growing demand, capacity constraints, and rationalization in the global refining industry continue to restrict the availability of waxes.

Paraffin and Fischer-Tropsch (F-T) waxes are used in hot melt adhesives. Paraffin wax is derived from crude oil and is a by-product of lube oil refining. F-T wax, also called hard-wax, is a synthetic wax produced via the Fischer-Tropsch process from the gasification of coal or natural gas.

A recent study by Kline & Company's Energy Practice predicts that global wax supply will grow by 1.4% per year through 2020.¹¹ Much of the growth will come from additional synthetic and vegetable wax capacity. However,

¹¹ Kline & Company, Inc. (2010, December). *Global Wax Industry 2010: Market Analysis and Opportunities*: <http://www.klinegroup.com/reports/brochures/y635a/brochure.pdf>.

FIGURE 5:
GLOBAL WAX CONSUMPTION (2010 EST.)



Source: Kline & Company, Inc.

The adhesives industry represents only a small segment of global wax demand.

the supply growth will not be sufficient to keep pace with a projected 2.3% per year growth in demand. This means the wax market will remain chronically tight.

Even though paraffin wax has become a relatively high-margin product that contributes to the overall profitability of a refinery, it does not influence the refining process. Refiners are in business to produce gasoline and base oils.

Changes in the base oils market in recent years have led to significant erosion in the North American paraffin wax supply. Car manufacturers' desire for higher performance lube oils and increasingly stringent environmental regulations calling for lower-sulfur fuels and higher-viscosity engine oils

have shifted refining toward higher-quality base oils. This has moved production from Group I refineries, which generate wax as a co-product, to Group II and III refineries, which do not produce wax. As North American refiners close Group I plants or convert them to Group II or III, the availability of paraffin wax drops.

In addition, the same feedstocks used to make wax can be refined into fuels and specialty oils. This means that when gasoline prices are high, as they have been for several years now, refiners may choose to keep feeds in the gas pool. By not fully refining the feeds into wax, refineries can run faster and produce more fuel. This improves margins, but also constricts the wax supply.

For the past several years, North American wax buyers have made up for domestic shortfalls by importing paraffin wax from China. However, as China's internal wax demand has grown, exports have dropped. According to the U.S. International Trade Commission, imports of paraffin wax from China in February 2011 were 75% lower than those in February 2010.

Shifting qualities of crude have also hit China's wax market. China has traditionally refined crude oil that was very waxy in nature, that is, it produced more wax per barrel than other grades of crude. As domestic demand for petroleum products has boomed, China has been forced to import crude. Since the imported grades are not as waxy as Chinese domestic grades, more crude must be refined to maintain wax production. The combination of growing demand and lower wax production per refined barrel has limited the amount of wax available for export and further curtailed China's supply to the North American market.

At the same time, the Chinese lubricants market is evolving and now demands higher-quality lubricants produced by Group II and III refineries, just as in North America. This has led to a shift away from Group I refining and resulted in flat-to-declining wax production.

Fischer-Tropsch wax capacity will grow in coming years as new capacity comes on the market. However, there are only two global producers of F-T wax. Both are currently selling all the wax they can produce to contracted customers with no excess wax available to supply new customers or to increase volume to existing customers. South Africa-based Sasol, the world's largest producer, has placed customers on allocation in order to manage supply. The company will have a new production line running in the second half of 2012. Shell Malaysia, the other global producer, is also scheduled to bring on additional capacity by the middle of 2012, much of which is earmarked for Asian road building applications.



Meanwhile, the demand for wax continues to grow. Paraffin wax is used in packaging applications and in candles, cosmetics, plastics, and fire logs. In recent years, the largest demand growth has come from the polyvinyl chloride industry, which uses wax as a plasticizer. Adding wax to plastics improves molding and extrusion characteristics. Wax is also finding new uses as a pavement additive that extends the temperature range within which road paving can be undertaken.

Wax supply is limited, if not declining, yet applications and demand continue to increase. The adhesives industry represents a small-volume market for the global wax industry. Wax producers choose their buyers. As supply tightens, wax buyers will be forced to compete to secure supply. Because the industry consumes low volumes compared to other industries, adhesives buyers may not have the clout needed to contain price escalation.

Rubbers

Synthetic rubbers, including styrene butadiene rubber (SBR), styrene butadiene styrene (SBS), and styrene isoprene styrene (SIS), improve the flexibility of hot melt adhesives. Two important factors are affecting the supply of rubber-related raw materials: the extremely high cost of natural rubber and the tight supply of butadiene.

Although natural rubber is not used in the formulation of hot melt adhesives, its fortunes have a significant impact. That's because synthetic rubber can be substituted for natural rubber in many applications, including tire manufacturing.

The tire industry is by far the largest consumer of synthetic rubber. In the mid-2000s, high synthetic rubber costs encouraged many tire manufacturers to increase their plants' ability to shift between natural and synthetic rubber feeds. Smaller producers were especially quick to retool plants and switch more readily to optimize costs.

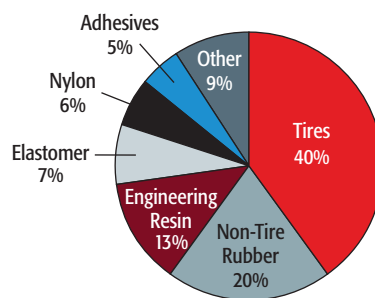
Tight supply, improving demand, and commodity market speculation led to a rapid and dramatic run-up in natural rubber prices in 2010. Inclement weather in the world's rubber-producing regions hampered harvests, reducing production and inventories. Meanwhile, demand is growing. The Association of Natural Rubber Producing Countries expects demand in China, the largest consumer of natural rubber, to grow by 9% in 2011. India's demand will increase by 5%.

“With strong demand growth, especially from those two countries, and unpredictable weather patterns affecting production, it is likely that global natural rubber supply will remain tight,” CMAI said in a recent report.¹² “In terms of pricing, the extremely high levels seen in the past several months are expected to continue in the coming months due to this tight supply.”

According to CMAI, past price ratios of natural to synthetic rubber remained within a fairly constrained range. In recent years, the ratio has broken out of that range, indicating a longer-term trend toward higher natural rubber prices. CMAI forecasts this trend continuing through the end of 2012 and beyond. This means that higher prices will encourage more natural rubber consumers to switch to synthetic rubber, leading to strong demand growth for synthetic rubber and its feedstock, butadiene. Growing demand for tires, especially in China, will amplify the trend.

For the adhesives industry, this demand growth can be translated into enhanced competition for available

FIGURE 6:
BUTADIENE: GLOBAL DEMAND

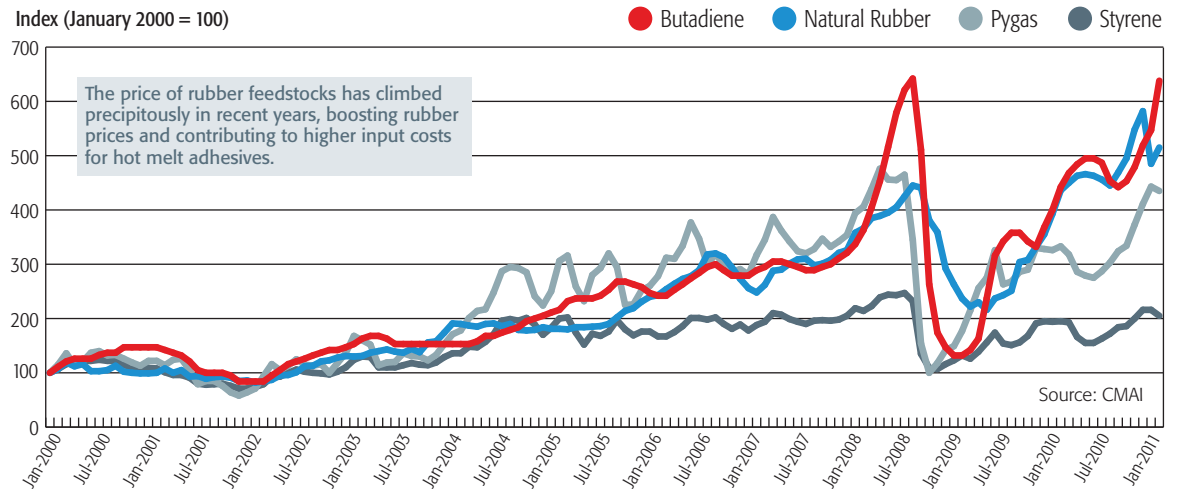


Source: CMAI

There are many diverse industries competing for the limited supply of butadiene. Tires represent 40% of the demand; adhesives, only 5%. As a result, market conditions in an unrelated sector can have serious repercussions for the supply and cost of raw materials for hot melt adhesives.

¹² CMAI. (2011, March 24). *Global Outlook for Feedstocks (C4s) & Elastomers*, 690.

FIGURE 7:
RUBBER COST DRIVERS



supply. That's because the adhesives industry accounts for only 5% of the global butadiene market, according to CMAI. Other industries, like tires, thus set the market and have a significant impact on supply and price. Since the adhesives industry is a much lower volume customer, the only way for it to compete successfully against the bigger players is to pay higher prices.

This kind of cost escalation will only intensify in coming years. The erosion of the North American butadiene supply, driven by the shift in cracking feeds outlined in the earlier section on shale gas, will play a large role. CMAI expects cracker feeds to trend lighter through the rest of 2011. DeWitt forecasts a 5% to 10% decrease in North American butadiene production in the next five years.¹³ Domestic butadiene production will continue to be limited by the availability of crude C4s and will rely increasingly on imports. The problem is that butadiene derivative demand growth in Asia is rapidly sucking up local supply and eating into export volumes.

The impact of these factors is evident in the accelerating costs of rubber feedstocks over the past decade. Since 2000, butadiene prices have climbed more than 600%. Natural rubber prices are up more than 500%. The cost of pygas, the precursor to isoprene required for SIS, has risen more than 400%. And the price of styrene, the most moderate of the group, has doubled.

These trends of shrinking supply, enhanced competition, and rising cost are expected to be permanent. They will contribute to the challenges faced in securing and paying for the rubber-based raw materials required for hot melt adhesives.

Tackifiers

Hot melt adhesives rely on a range of natural and hydrocarbon tackifiers to improve performance. Natural tackifiers are based on rosin esters, which include gum rosins produced by tapping pine trees in China or Brazil, and crude tall oil rosins, which are created as a by-product of the pulp and paper manufacturing process. Hydrocarbon tackifiers are produced from C5 and C9 resins and can be further processed to produce higher-grade hydrogenated hydrocarbon, or water-white, tackifiers.

Soaring gum rosin prices, constricted feedstock supply, and shifting demand patterns have tightened the tackifier market in recent years. Most tackifiers are not interchangeable in a given formula, but when the supply of one feedstock becomes scarce or its costs escalate, formulas using other types of tackifiers become more attractive.

¹³Tom Brewer. (2011). Trends in Butadiene & SBS.



Most of this type of substitution tends to drive customers up the tackifier quality curve, moving demand to higher-quality, and higher-priced, tackifiers. The interconnectedness of the tackifier supply chain means that shifts in the supply and price dynamics of one tackifier feedstock can reverberate along the entire chain.

Poor growing and harvesting conditions, labor shortages, increasing domestic demand, and rampant market speculation propelled Chinese gum rosin prices to all-time highs in 2010. Prices continue to rise in 2011 with only recent signs of softening due to the coming spring harvest. The escalating prices have motivated many gum rosin users to seek alternatives, however. This has increased demand for crude tall oil rosin, which is the closest alternative to gum rosin.

As the same time, crude tall oil supply has constricted. Demand for paper declined during the recession, slowing pulping operations and leading to a reduction in crude tall oil production.

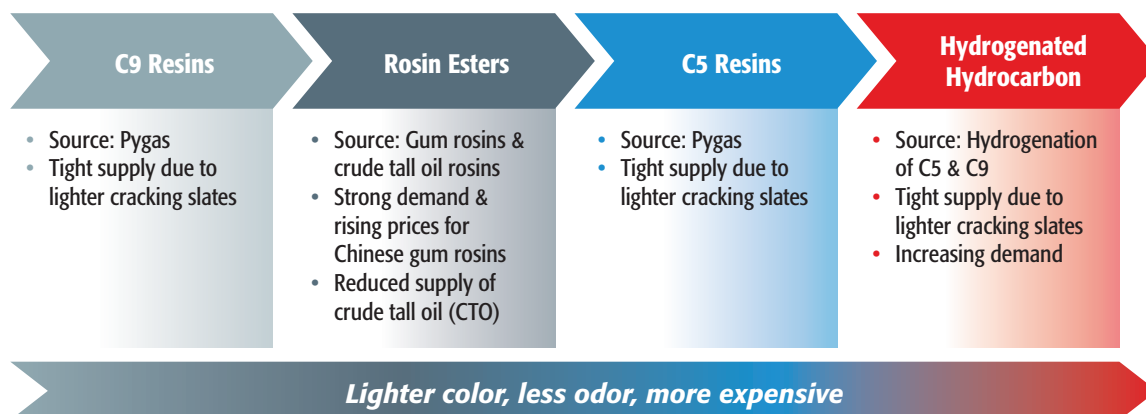
Strong domestic demand for Chinese gum rosin along with its rising cost and the tightness in crude tall oil rosin has tightened the supply of the rosin esters used to produce rosin tackifiers. This has forced many users to shift demand to hydrocarbon tackifiers.

The problem is that hydrocarbon tackifiers are also experiencing feedstock supply constraints. The raw materials used to make hydrocarbon tackifiers come from the pyrolysis gasoline (pygas) stream produced by olefins crackers. As explained earlier in the section on shale gas, the shift of cracker feeds to lighter ones based on ethane is reducing the volume of pygas produced. Pygas quality is also being affected. The pygas produced from ethane contains less of the C5 and C9 molecules required for tackifiers, which means that tackifier producers must process higher volumes of raw materials to generate the required output. This is tightening supply and driving prices higher.

C5 and C9 can also be hydrogenated to form hydrogenated hydrocarbon or water-white tackifiers. This extra processing step delivers lighter-colored, better-smelling tackifiers that improve the performance of hot melt adhesives. As many hot melt adhesives users have come to rely on the clean machining and improved aesthetic of water-white tackifiers, demand for the tackifiers has risen.

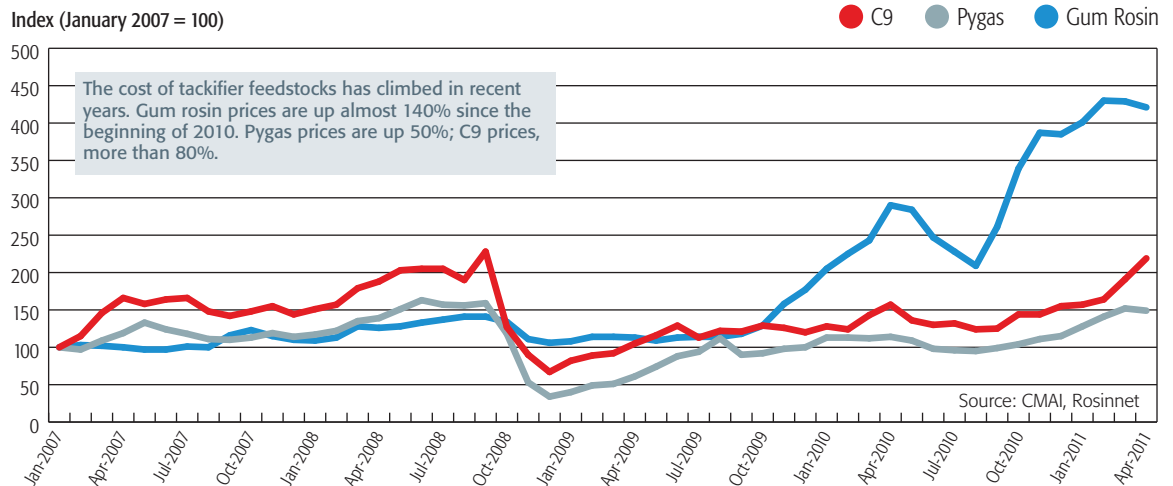
Simultaneously, the demand for many products that rely on water-white-based hot melts has grown. The hot melt adhesives used to construct disposable diapers and napkins represent the largest market for water-white resins. High birth rates and an expanding Asian middle class with more disposable income, especially in India and China, are driving demand for diapers and other disposable hygiene products. In Western countries, an aging population is increasing demand for similar adult products, adding to water-white resin demand.

FIGURE 8:
TACKIFIER SPECTRUM



As rosin ester prices have risen in recent months, tackifier users have sought lower-cost alternatives. This has shifted demand farther along the tackifier quality spectrum, increasing competition for existing supply.

FIGURE 9:
TACKIFIER COST DRIVERS



As the supply for each type of tackifier has tightened and costs climbed, tackifier users have migrated along the tackifier spectrum to other tackifiers. This demand shift has led to both an overall tightening of tackifier supply and rising costs across the tackifier spectrum.

Gum rosin prices are expected to remain elevated in the short term. Most of the debottlenecking that was possible in the tackifier stream has been done. Some new capacity for C9 tackifiers has come online, but since these are the darkest and smelliest of tackifiers, few end-users are willing to switch back to hot melt formulations that use them. Many tackifier suppliers claim they could sell greater volumes than they can currently produce. That doesn't mean that new capacity will come online anytime soon. Ongoing uncertainty about the economy and fiscal conservatism mean that it will be difficult to convince company management to invest in new capacity.

The tightness in tackifier markets will most likely continue in the near term, given that it typically takes 18 months to build a new tackifier plant. As demand increases, competition for materials will escalate, which will continue to drive prices higher.

Ethylene vinyl acetate (EVA)

Many people are familiar with ethylene vinyl acetate (EVA) in the form of a comfort-enhancing, shock-absorbing foam layer in the soles of their athletic shoes. In recent years, EVA has emerged as the encapsulant of choice for solar modules used in photovoltaic panels. It's also a critical component in many hot melt adhesives.

The difference between the grades of EVA used in shoes, solar panels, and adhesives is at the heart of the adhesives industry's long-enduring battle to secure enough EVA to satisfy hot melt demand. Unfortunately, the adhesives industry appears to be losing ground.

EVA is formed through the copolymerization of ethylene with vinyl acetate monomer (VAM). Varying the amount of vinyl acetate in the mix changes the characteristics of the EVA. EVA with a high content of vinyl acetate tends to flow easily and be soft and sticky, which is perfect for adhesives and photovoltaic applications. Low-VA-content EVA is harder and less malleable, and it doesn't stick, making it right for shoes. The same stickiness that is so attractive to adhesives formulators can be a hindrance to EVA producers because it slows plant speeds, reducing production and increasing costs. As a result, low-VA-grade EVA tends to be easier to produce and have higher margins than adhesives-grade EVA.



Most EVA plants can manufacture a range of products, starting with low-density polyethylene (LDPE; it is most commonly used in plastic bags) and progressing through ever-higher proportions of VA-content EVA. Producers shift output on the basis of economics and demand to optimize their margins. This means that as demand for shoes has rebounded following the recession, EVA producers have shifted production to make more low-VA-content EVA at the expense of the EVA needed for adhesives.

In recent years, a boom in the photovoltaic industry has also contributed to the EVA supply dynamic. The EVA used as an encapsulant for solar modules is of slightly higher vinyl acetate content than that required for adhesives. It is close enough, however, that the new EVA capacity being brought online to serve the photovoltaic market is capable of being used for adhesives-grade EVA. That doesn't mean that producers will be willing to make adhesives-grade EVA, though.

The problem is that the photovoltaic industry is a higher-margin market for EVA producers. Suppliers are increasingly shifting their focus away from adhesives-grade EVA to target production for photovoltaics.

As a result, the adhesives industry is being squeezed out of the supply stream and now must fight to secure supply, often by paying hefty premiums. Some suppliers, however, have made strategic decisions to exit the adhesives-grade market, and no price premium will entice them to reconsider. This trend does not bode well for the longer-term supply of adhesives-grade EVA.

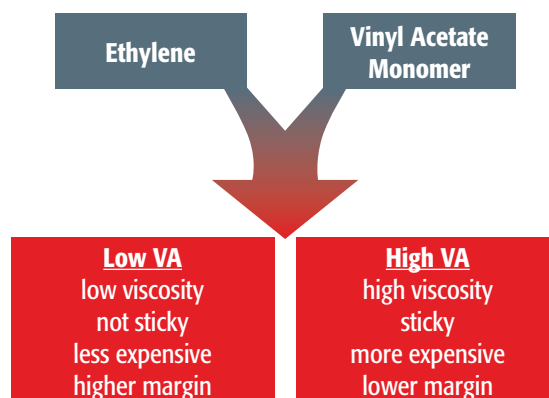
Issues of upstream feedstock availability for VAM, and therefore EVA, have also been of concern in recent years—there have been a number of supply disruptions, declarations of *force majeure*, and implementations of sales allocations on the part of suppliers. The Asian market, in particular, has been tight. Many of these issues are transitory, or at least should be resolved with time. Any threat to supply from feedstock issues is greatly overshadowed by those coming from suppliers choosing to no longer supply the adhesives market.

Surprisingly, the shale gas boom also has the potential to disrupt domestic EVA markets. Ideally, the lower production costs resulting from abundant ethane feeds should position North America as a low-cost ethylene producer. This should, in turn, benefit North American VAM producers. This benefit might not trickle down to domestic buyers of VAM and its derivatives, however. That's because as North American production costs decrease, VAM producers are discovering that they can generate higher margins by exporting VAM and EVA polymers than they can by selling them domestically.

This shift of volume to the export market is tightening local supply. It will also force North American VAM prices to rise to a level comparable to that of VAM produced by higher-cost ethylene from overseas naphtha crackers, effectively eliminating any cost advantage imparted by the shale gas effect. According to CMAI data, January 2011 vinyl acetate exports to China increased by a factor of eight compared to January 2010 levels.¹⁴

Recent production outages at Chinese acetic acid (the feedstock for VAM) and VAM plants are most likely responsible for the bulk of the increased imports. What percentage is related to North American VAM producers

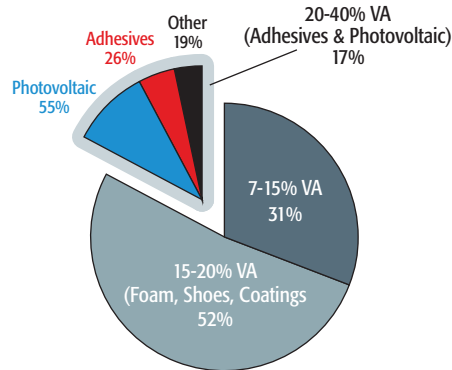
FIGURE 10:
ETHYLENE VINYL ACETATE



EVA producers can vary output, ranging from low-VA content EVA to high-VA content EVA, based on demand and margins. This calculation often works to the detriment of the adhesives industry.

¹⁴ CMAI. (2011, March 22). *Global Acetyls Market Report (Prototype)*, P001.

FIGURE 11:
GLOBAL EVA DEMAND



Source: CMAI, Henkel

The adhesives industry is a relatively small player in the global EVA market.

taking advantage of arbitrage opportunities is unclear.

Regardless of cause, the result is tightened supply of both VAM and EVA in North America. The outlook isn't good for the health of EVA supply for the adhesives market.

In the end, the most worrisome outcome of the evolving tight supply environment is the way in which suppliers are aggressively abandoning their least profitable markets and customers. Suppliers are employing increasingly sophisticated analytics to evaluate the profitability of their customers. Supplier companies are also rethinking strategy and positioning themselves to better serve markets that are perceived as high-return and high-growth, which is forcing changes in longstanding pricing methods

and formulas. Unfortunately, this is leaving the adhesives industry out in the cold.

The Henkel Global Advantage: Fighting for Supply Security

There is little that the adhesives industry can do about its size relative to the other industries that compete for the same raw materials. There is, however, a lot that Henkel is doing to mitigate the impact of supply threats on its customers.

No single action will counteract the complex drivers in today's hot melt raw materials market. Henkel, therefore, relies on a multifaceted strategy to ensure ongoing supply. This involves four areas of focus: purchasing, application expertise, proactive product management, and industry-leading innovation.

Henkel's purchasing professionals foresaw many of the threats explored in this report and have been preparing for them for some time. The team's mission is to identify, develop and negotiate the best sources of existing raw materials for the company's adhesives. This is ongoing work but it has taken a new, more urgent turn with the changing landscape of raw materials supply and cost.

One result is the development of several new sources of tackifier raw materials in the Far East and Latin America. New sources and new suppliers ensure that Henkel can develop and grow a reliable, sustainable supply of raw materials to serve the adhesives market. These programs also deliver cost savings, which can be passed on to customers. While the magnitude of the cost savings is not insignificant, it only offsets a small fraction of the recent rise in raw materials costs. That's why additional programs are critical to the long-term health of the industry.

For years, Henkel's application expertise has helped customers to improve the efficiency of their adhesives use. Innovative new adhesives technologies have consistently reduced adhesives use, lowered energy consumption during the application process and improved performance. Not only has this expertise saved customers money, it has also relieved pressure on overall hot melt demand. That, too, isn't always enough.

In some cases, more dramatic measures are required to head off supply threats and shelter customers from the potential for outages. Sometimes, this means proactively retiring one of the company's most popular products. Henkel recently announced the discontinuation of one its highest-volume packaging adhesives because the threat to the supply of raw materials was untenable and the potential impact on customers unacceptable.



By replacing that product with a completely new, more robust and sustainable formulation, Henkel has eliminated reliance on many of the most constrained raw materials. If the company had not taken such a bold step to address the supply issues in the industry, it would not have been able to satisfy demand. This would have resulted in reduced allocations for customers, which is not acceptable.

Henkel is committed to providing its customers with the volumes of adhesives they need to grow and prosper. Imposing allocations is a practice of last resort, one that Henkel is doing its utmost to avoid. In today's environment, that often means making difficult, even unpopular, decisions all in the name of delivering the most secure supply to our customers.

Finally, Henkel is leading the industry in the investment in product development and advanced research. Henkel's Research and Development team is aggressively pursuing new technologies and developing innovative new formulation approaches that bypass many of the current raw materials bottlenecks. With a pipeline of promising projects under development, the company expects many of today's supply constraints will one day be overcome through its innovation.

The threats to traditional hot melt raw materials supply are not going to disappear. For adhesives customers, security of supply is now of utmost importance to long-term business stability and growth. Price has become a secondary concern. The only insurance against supply insecurity lies in partnering with the industry leader.

Henkel's scale and global reach allow it to navigate today's rapidly changing supply landscape better than any other company in the industry. As the leading supplier of industrial adhesives, Henkel has a proven track record of supplying customers in challenging times. With long-term strategic supplier relationships and best-in-class R&D capabilities, Henkel remains the clear partner of choice for the unprecedented hot melt challenge that lies ahead.

For more information on how Henkel is working to ensure hot melt supply for its customers, please contact your Henkel Sales Representative.

For timely updates on industrial adhesives raw materials issues, please consult the latest edition of the *Raw Materials Facts* newsletter, available in hard-copy format from your Henkel Sales Representative and online at <http://www.henkelna.com/industrial/raw-materials-facts-11048.htm>.

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