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## Petrochemical Insights: MEG

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RECENT SPIKES in the price of monoethylene glycol (MEG) and its major co-products, diethylene glycol (DEG) and triethylene glycol (TEG), with near-term forecasts that global pricing on ethylene glycols and downstream products will face upward pricing pressure, should come as no surprise to those who are familiar with the market history of these basic chemical building blocks.

### Recent History

To understand current MEG market conditions and prepare for the future one must look at the history of this market.

From 1980 to 1987, worldwide supplies of MEG more than satisfied the requirements for primary MEG users as well as those companies buying and selling downstream products. During this extended period, it was virtually impossible to make a profit based strictly on the sale of unimproved MEG products, and the global market saw little to no reinvestment in MEG production capacity.

In 1987 a series of industrial disasters began with the July explosion of British Petroleum's world scale ethylene oxide (EO) plant in Antwerp, Belgium. Texaco and Shell production facilities experienced fires, significantly lessening worldwide oversupply and driving up prices in a very short period. In 1988 BASF's EO plant in Antwerp also suffered an explosion, continuing to constrain global MEG supplies. It was not until 1990 that worldwide capacities caught up with demand and eventually began to achieve a surplus, which stabilized and then significantly lowered global MEG prices.

### Annual MEG Demand Increase

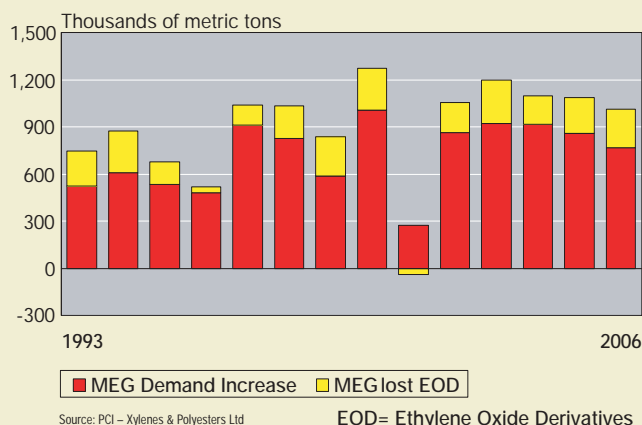


Figure 1

### World EO Rate vs Price

Can 89% ever happen? Even at \$1,000 per metric ton?

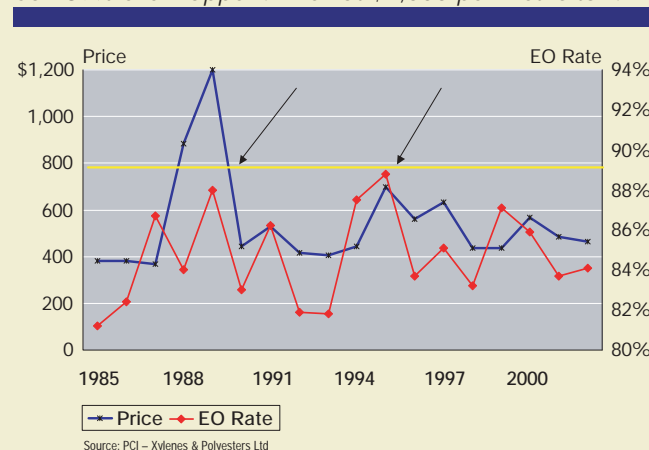


Figure 2

Over the course of the next five years, reduced margins once again created an oversupply environment with little incentive for companies to reinvest. In fact, during late 1994 and early 1995, many MEG producers began reducing production capacity and cutting inventory levels, which in a short time began to tighten the global supply with concurrent higher selling prices. When chemical producers are faced with long periods of low or negative profitability, reinvestment decisions are delayed, supply grows short, and many companies achieve little better than break-even results.

With the beginning of the new millennium, the global economy took a surprising downturn, which resulted in a downward spiral of MEG demand and pricing. In December of 2000, 100,000 metric tons of annual MEG capacity was lost when Huntsman's EO reactor at Port Neches, Tex., exploded and was not rebuilt because of poor margins. Increased Middle East and Asian capacity, combined with high natural gas crude prices in early 2001, took their toll on North American MEG producers. With no economic recovery in sight, many MEG producers decided to reduce production in the face of mounting losses.

One year after the Dow Chemical purchase of Union Carbide, the global market collapsed totally, leaving Dow with no choice but to moderate its huge global capacity to try to manage the oversupply. Thus, the world's largest MEG producer shut down its Taft I 350,000 metric ton EO/MEG unit in December 2001.

Essentially all other MEG producers reduced their operating levels to help stem the tide of mounting losses.

The idling of this world scale plant for 14 months took 400,000 metric tons of EO or nearly 500,000 metric tons of MEG production out of the global supply. Weak demand in 2001 delayed the inevitable; however, as demand rebounded in 2002, margins did not. These low margins and high operating costs forced BASF to stop US EO/MEG production in late 2002 after earlier announcing the permanent closing of its 350,000 metric ton MEG unit at Geismar, La.

The scheduled idling of Dow's Taft I plant and the partial shut-down

## World MEG Balance

Thousands of metric tons

	2000	2001	2002	2003
MEG Demand	12,228	12,499	13,361	14,284
MEG Production	11,978	12,426	13,086	13,957
Inventory Change	-250	-73	-275	-326
Year Demand Increase	953	271	862	923
Year Production Increase	806	449	660	871
EO Rate	85.9%	83.1%	84.1%	89.4%

Source: PCI-Xylenes & Polyesters Ltd.

Figure 3

of BASF's EO/MEG production facility have taken out over 680,000 metric tons of MEG production, contributing signs which pointed toward an impending global price adjustment.

### Now in 2003

In early 2003, the reopening of Dow's Taft I plant may seem to offer a bit of relief for MEG buyers. However, the company has already scheduled for planned maintenance shutdowns at its EO plant in Seadrift (the world's largest) in early March and its Malaysian plant, which is currently down for seven weeks until the end of March. The Prentiss I, Alberta, Canada, MEG plant will go down in late April, followed by Taft II in early May. Shell is scheduled to have all three of its EO/MEG plants off line during the first quarter and second quarter, with its largest US unit down later this month. Other producers will have their turnarounds in mid-year or sooner depending on catalyst performance. The result will be that global MEG production is lower this year than in the recent past.

### Global Factors Affecting MEG

In response to tightening demand and skyrocketing raw materials costs, MEG producers as a whole have taken their inventories lower and lower each year, in an effort to balance costs and production with demand. Concurrently, worldwide demand for MEG came storming back by mid-2002, increasing some 800,000 metric tons primarily influenced by Asian MEG demand—most notably China's +500,000 metric tons increase to support its domestic polyester textile needs and the ongoing global growth for polyethylene terephthalate (PET) packaging resin.

In recent years, world MEG prices have been significantly influenced by China spot prices as Chinese buyers use their group purchasing power to keep global MEG prices low. As demand surges, like it has since late 2002, the influence of Chinese spot buying practices could not significantly overcome the influence of shortages in MEG, terephthalic acid (PTA) and paraxylene (PX).

The growing influence of Asian MEG demand and increasing expansion by chemical producers in Taiwan, Iran, Saudi Arabia, Kuwait and China, spotlights North American companies' continuing challenge to maintain their global market share through utilization of this production capability which, once lost, can never be recouped. In addition, the volatile nature of the Middle East and other regions in which these new world-scale plants are being built makes it very likely that they may not be completed on time or be capable of delivering their intended capacity of product, possibly further extending the supply role of North American MEG producers in the global market.

Other factors influencing the global market include that MEG has a seasonal demand, while PET resin production is driven by a second quarter-third quarter demand surge. Antifreeze production tops out by the end of the first quarter, and the increasing influence of Chinese MEG requirements (currently importing about 3 million metric tons per year) swings partially around the Chinese New Year. The Chinese tactic of driving down spot prices by buying two months worth of MEG, and then waiting to make another large purchase again, adds to the continuing instability

in demand and supply.

Global requirements for MEG continue to grow (2002 usage was up 800,000 metric tons), while MEG suppliers continue to draw more and more out of a surplus inventory that is currently at near zero levels (Figure 1).

Low prices have forced producers to lower their working capital to the point where all the flexibility is out of the system. This "bottoming out" of global supplies is what has brought us to a situation where any unplanned upsets could catalyze a spark in spot prices, possibly raising them to the highest level in history.

The fact that spot MEG prices increased from the high \$400s in late December 2002 to \$700 by the end of January is a tell-tale sign that something is askew. Unless MEG supplies improve quickly, prices will keep rising. Add to this the fact that many producers cannot sell as much in 2003 as they did in 2002 because they have depleted their inventories. Several producers have already implemented MEG and co-products sales control programs.

### MEG Supply

The biggest increase in MEG supply for 2003 must come from Dow in the US and Nan Ya in Taiwan. Nan Ya should make more from its existing plants (ethylene availability is a concern) and its new plant should start in the fourth quarter. That is only a 350,000 metric ton plant, so it will not be enough to meet continuing market growth.

Even if the remaining EO/MEG producers exceed expectations and produce at 91 percent of their ultimate potential (an increase of 100,000 metric tons), the loss of BASF's 300,000 metric tons would result in a net loss of 200,000 metric tons in world inventory. Based on 100 percent nameplate capacity (US plants have, historically, never exceeded 89 percent, with an average of 80 to 85 percent at best) and less planned turnarounds, MEG supplies for the remainder of 2003 will fall far short of projected increased demand by more than 300,000 metric tons (Figure 2).

As of now, we see MEG production for 2003 of no more than 13.9 million metric tons, while demand is expected to exceed 14.2 million metric tons (Figure 3). This means that the 2003 industry deficit will be the equivalent of more than one world scale plant, and this deficit will likely double in 2004. There is essentially no inventory to comfortably meet the difference, so MEG availability will continue to be tight for at least the next two years, and MEG prices will continue to rise.

The only good thing about rising product prices is that the potential for increased profits should encourage companies here and abroad to reinvest in the business, which will improve chances that worldwide production will eventually catch up with or exceed the growing demand, giving buyers another opportunity to take advantage of a new cycle and drive MEG prices down.

Hopefully, for MEG buyers there may be rapid capacity creep as margins will now justify maximum EO rates and fast debottlenecks. If we

### World MEG Inventory & Demand

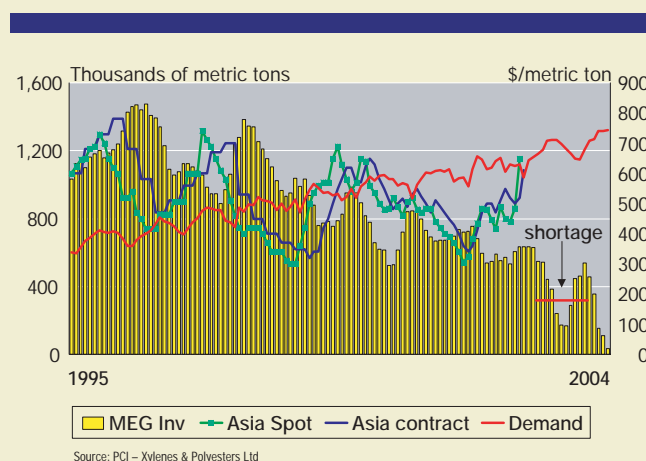


Figure 4

assume that producer MEG inventory cannot go below 300,000 metric tons, then in the future, demand can only equal supply creating about a 20,000 to 30,000 metric-ton-per-month deficit for most of the third quarter in every year. Demand would then carry over into the fourth quarter due to lack of supply and the seasonal slowdown would be delayed.

The most intriguing issue continues to be how all of this will play out in China, where accelerated growth of textile production is expected to generate MEG demand increases in excess of 1.7 million metric tons from 2002 to 2004 (Figure 4). Eventually, it will come down to a bidding contest as to who will get the MEG. The question will be which MEG end-use markets will bid for the available glycol. PET resin is keeping ahead of the game with increases of 18 cents per pound announced for the first four months of 2003. The world fiber markets are having a difficult time understanding their feedstocks, and thus may be the last to accept the fact that MEG is getting tighter.

## China Is Key

In recent years, Chinese cooperative buying groups have forgone globally accepted contract buying practices in favor of highly volatile spot buying. These methods have negatively influenced global prices for the past three years. China has had a relentless expansion of fiber, chip and PET capacity, with essentially no real analysis of where they will sell these industrial products or any attempt to look beyond one month to the next.

It seems doubtful, however, that China will be able to “play the game by their rules” in the next few years, since they will find it increasingly expensive, time-consuming and difficult to spot buy to keep up with their escalating demand for MEG. If China does not begin to pre-buy or plan accordingly, they will not be able to influence the market price as they have in the last few years.

## The Polyester Chain

Throughout the polyester chain, margins will most certainly be impacted. Paraxylene, PTA and MEG suppliers can and have achieved selling prices at or near historical highs. Currently, PX and PTA reflect global crude oil values, but they should subside; PTA should be in surplus in 2003.

While the temporary shortage of PX and higher PTA prices are solvable at a price, today's MEG supply situation is not. PX is available, at a higher price, from the US aromatics pool. Today's MEG supply, however, is coming almost exclusively from today's production. So whether buyers offer \$700 to \$900 or more per metric ton, it will not generate any significant extra MEG and exploit the greater short-term weaknesses of the PTA and PX markets, thus trying to break the MEG price. MEG prices will hit \$800 per metric ton and may stay there for the foreseeable future. Should resin prices increase to absorb all feedstock cost increases in the first quarter and second quarter this year, they may or may not remain high in the third quarter and the fourth quarter. As PX and PTA prices adjust downward, there is a great potential for MEG to rise again, espe-

## MEG Expansions

Company	Amount of Expansion (Thousands of metric tons)	Expected Start-up
• Nan Ya #3, Taiwan	350	Q4 2003
• NPC Iran	400	Q4 2004
• JUPC, Al-Jubail	575	Q1 2005
• BASF China	320	Q1 2005
• NPC Iran	440	Q4 2005
• Shell China	320	Q4 2005
• NPC, Iran	400	2006
• Kuwait	650	2006-07
• Singapore, Iran, Venezuela	1,300	2007

Source: PCI-Xylenes & Polyesters Ltd.

Figure 5

## New MEG Demand vs New Effective Capacity

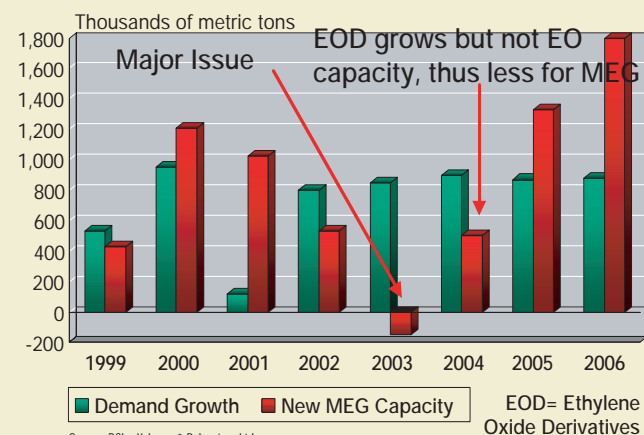


Figure 6

cially if China is viewed to be the incremental MEG buyer.

While some predict that it will be difficult to repeat the highs of 1988-1989, with Asia CP at over \$1,400 per metric ton, anti-freeze-grade at 50 cents per pound and EO at 65 cents per pound, the deficit in MEG during 2003 and 2004 could create a situation that is even tighter than in the late 1980s.

Natural gas prices have become an issue again in North America, due to colder than normal weather driving up prices. The impact of oil on naphtha cost in Asia and Europe will continue to put pressure on ethylene prices as well.

## MEG Expansions

Global supplies of MEG are expected to remain extremely tight throughout 2004. The main reason for this is that, other than Nan Ya in Taiwan, the next two international MEG plants under development are in Iran (400,000 metric tons) and Saudi Arabia (a huge 575,000 metric ton plant at JUPC in Al-Jubail). The earliest they could come on line would be the first quarter of 2005 (Figure 5).

Once again, political and military uncertainty in the Middle East and North Korea make it unclear whether they will be completed on time, or if normal market dynamics can return to these volatile regions. A military event in the Middle East could disrupt MEG supplies for an indeterminate amount of time.

Among the other world-scale MEG plants in development is a 300,000 metric ton BASF plant in China, which will more than likely be absorbed by the Chinese textile industry's domestic demand. It is also fair to assume that Saudi Arabia and Iran MEG producers will target China. Given the unpredictable spot buying practices employed by Chinese buying groups, the increased volume of MEG sales to China could be a recipe for a price collapse of record proportions. However, due to tight global ethylene supplies in this time frame, prices may not drop as much as history predicts.

## Looking Ahead

Ethylene derivative exports to China from Japan, Canada, Korea and Taiwan will be thoroughly tested in 2004 and 2006, but the bigger issue is what the future holds for US MEG producers. Once the tight ethylene market arrives, perhaps as early as the fourth quarter 2004, US and Canadian producers will not want to export MEG (Figure 6).


The US market currently has sustained annual imports of about 100,000 metric tons of MEG, and there is no chance that this can increase until 2005. On paper, the US market is balanced until 2005, with production equaling demand. Imports from Canada and Saudi Arabia will force out exports, but eventually lower priced imports from Saudi Arabia will determine when and how much must go out. If Canada chooses to bring in up to

200,000 metric tons (rather than go to Asia) then US producers will be under pressure to throttle back production again, which will create a ripple effect throughout the US MEG industry.

Looking even farther out, the pain may not be over yet for US MEG producers. Accelerated Middle East imports to the US, coupled by the increase in world supplies resulting from the opening of Exxon/Mobil's new MEG plant in Venezuela (projected for 2007) will put even more pressure on their margins. Pricing pressure will further cripple the future of domestic MEG production, making it doubtful whether many companies will have the economic courage to re-invest in this business in North America. This places real doubt on the future of MEG production in the US and leads to greater emphasis on the importance and influence of Middle East and Asian production in future MEG global pricing.

The picture is not entirely bleak, however. Some forward-integrated US MEG producers such as Eastman Chemical, Formosa and Industries

should be in a better position to sustain their long-term domestic production and reinvestment. They have automotive and polyester fiber or PET resin businesses that use a good portion of their capacity downstream from the ethylene glycol molecule.

The global EO/MEG market will continue to experience dramatic adjustments both in pricing and availability over the next few years, as the various end-user industries vie for available product and world-scale production comes on and off line. Viewed in the context of historical ethylene glycol production and pricing trends, this is to be expected. How world-scale EO/ MEG producers and their downstream customers react to the current market difficulties and opportunities, will shape the supply and demand balances for the future. 

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