KPMG

REACTION

Chemicals Magazine
Eighteenth Edition / December 2015

Taking a deep dive into cyber security, working capital and the Korean chemical industry

KPMG GLOBAL CHEMICALS INSTITUTE

KPMG International

kpmg.com/reaction

Introduction

Welcome to the latest edition of REACTION Magazine and the last one for 2015. Overall, it's been a good year across the industry, but one that has not been without its challenges as companies have responded to the ongoing oil price decline, volatility in China and slowdown in other emerging markets.

In this edition, we bring you a focus on what chemical companies are doing to drive excellence in working capital performance. We also take a look at the chemical industry in Korea, as well as the increasingly important area of cyber security and what chemical companies can do to protect themselves from external threats.

As ever, we continue to be active in the industry, with members of our Chemicals and Performance Technologies leadership team recently touring a number of chemical facilities in China as well as hosting our 11th Annual Chemicals Executive Dinner in Shanghai – it was great to see so many familiar faces.

We'll be back with our next edition in March with a focus on strategic challenges facing chemical companies and the latest in our ongoing supply chain excellence series. If there are any other topics you would like us to cover in future editions of REACTION, please don't hesitate to contact us.

In the meantime, for those of you celebrating the forthcoming holiday season, please accept our very best wishes from the global chemicals team here at KPMG.

Mike Shannon
Global Chair
Chemicals and
Performance Technologies

Content

02 **Integrated control systems: new opportunities and cyber risks for chemical manufacturers**

The successful merger of control systems with Big Data 4
A question of security 5
Not all security is alike 6
Breaking down silos 7
A strategic, collaborative approach to security 8
Conclusion 8

10 **Cash is always king: how chemical companies are optimizing their working capital**

Maintaining cash discipline 12
A plan for all seasons 13
Developing a cash culture 13
Optimized, not just minimized 14
Strong frameworks for sustainability 15
USD2 billion in cash: a case study in working capital management 16
Expect the unexpected 16

18 **Korean chemical industry moves toward growth and diversity**

Key facts about the Korean chemical industry 20
A major player in petrochemicals 23
The advantages and risks of Chinese markets 24
Squeezed by petroleum prices 25
New directions for a maturing industry 27
Conclusion 28

Integrated control systems:

new opportunities and cyber risks for chemical manufacturers

By **Tom Burton** and **Roy Mcnamara**

Once designed to operate in isolation, chemical manufacturing control systems are now being connected to the virtual world. Production data from control systems are integrated with IT analytic tools and online resources to help reduce production costs, enhance operational efficiencies and improve maintenance. However, control systems that are open to data exchange are also open to the possibility of cyber attacks ranging from espionage to physical damage in the plant. An inclusive approach to cyber security that brings together engineers, IT professionals and corporate leadership can help chemical manufacturers benefit from the latest technology while maintaining a strong security posture.

The successful merger of control systems with Big Data

Control systems 'make things happen' in a modern chemical manufacturing plant. A combination of hardware devices, software and internal networks are used to activate, manage and monitor physical assets such as pumps, motors, conveyors and valves during the chemical production process. Components can include supervisory control and data acquisition (SCADA) systems, distributed control systems (DCS), and other control system configurations such as programmable logic controllers (PLCs).

With the development of internet connectivity, the cloud and other virtual technology, chemical manufacturers are integrating control systems with data analytics, enabling them to extract and analyze a large amount of production-based Big Data. This merger can help to improve process efficiency, streamline procurement, detect potential system failures and support new operational strategies for increased competitiveness.

Big Data and analytics can also help identify new business opportunities such as repurposing underutilized resources and reducing operational costs through shared infrastructures and services. As an added benefit, control system processes that were once 'fixed' can now be more easily updated, expanded, repurposed or redesigned.

In a recent KPMG survey of 350 IT and engineering managers, 48 percent agreed that by connecting their production systems to their corporate IT systems, they will have the data that will enable them to do proactive strategic planning, and half agreed that Big Data techniques may identify new opportunities for their business that they had not been able to previously identify.[1]

> "The merger of **control systems with data analytics** can help **improve process efficiency** and support new strategies for **increased competitiveness**."

[1] Conducted for KPMG by Onepoll.com, April 2015

A question of security

With increased IT integration, control systems are becoming more complex, more adaptable and more interconnected with both internal and external networks – all of which can lead to security issues.

In the past, control systems were by their nature resistant to unauthorized entry and manipulation. Plants used a mix of manual devices and analog components that operated on fixed instructions wired into circuitry. The hardware was highly specialized, the software was proprietary, and the overall system was designed to operate in isolated, physically secured areas that had little or no connectivity with corporate IT systems, not to mention the outside world through the internet. As a result, control systems were thought to benefit from 'security by obscurity.'

Today, however, security by obscurity is no longer a valid assumption. Some manufacturers use commercial-off-the-shelf (COTS) software or widely available Ethernet and internet protocol devices instead of proprietary solutions, and these products can introduce security vulnerabilities. In addition, today's internet search tools make it easier than ever for attackers to find control systems, either directly through corporate IT environments or indirectly through supplier networks and social media platforms. Once the attackers gain entry to the control system, they can take advantage of the automated, interconnected environment to perform any number of malicious actions.

A German steel mill was attacked in 2014 through a spearfishing campaign that tricked targeted employees to reveal their login names and passwords.[2] The attackers were then able to access the mill's production systems to inflict physical damage to a blast furnace.

In 2005, internet worm infections knocked 13 of DaimlerChrysler's US automobile manufacturing plants offline for almost an hour, stranding workers as infected Microsoft Windows systems were patched.[3] One of the most highly publicized attacks involved the Stuxnet worm in 2010. Although designed to target only specific SCADA systems, its effectiveness underscored the serious potential for harm by cyber attacks.

We should also keep in mind that cyber attacks on manufacturers are not limited to control systems. In 2011, at least 29 companies in the chemical sector and 19 in related sectors were targeted by Nitro, a Trojan malware, to gain access to the corporate IT environment.[4] The purpose of the attack was apparently the theft of intellectual property.[5] Companies affected included Fortune 100 companies involved in the research and development of chemical compounds and advanced materials, as well as companies that develop manufacturing infrastructure for the chemical industry.

As with any other business risk, the threat of cyber attacks should not be underestimated. At a 2014 conference for the chemical industry hosted by Siemens, nearly 30 percent of attendees reported that their company had detected a breach of industrial security, and over 80 percent agreed that industrial security is a growing threat to their business.[6]

> "In 2011, at least **29 companies** in the chemical sector and 19 in related sectors were targeted by **Nitro, a Trojan malware**, to gain access to the **corporate IT environment**."

[2] Hack attack causes 'massive damage' at steel works, BBC News, 22 December 2014, www.bbc.co.uk/news/technology-30575104
[3] DHS control system Security Presentation, www.slideshare.net/guest85a34f/dhs-ics-security-presentation
[4] The Nitro Attacks: Stealing Secrets from the Chemical Industry, Symantec, 2011
[5] Nitro Malware Targeted Chemical Companies, InformationWeek: Dark Reading, 1 November 2011
[6] Minimising cybersecurity risk for the chemical sector, ENGINEERLIVE, 15 April 2015

Not all security is alike

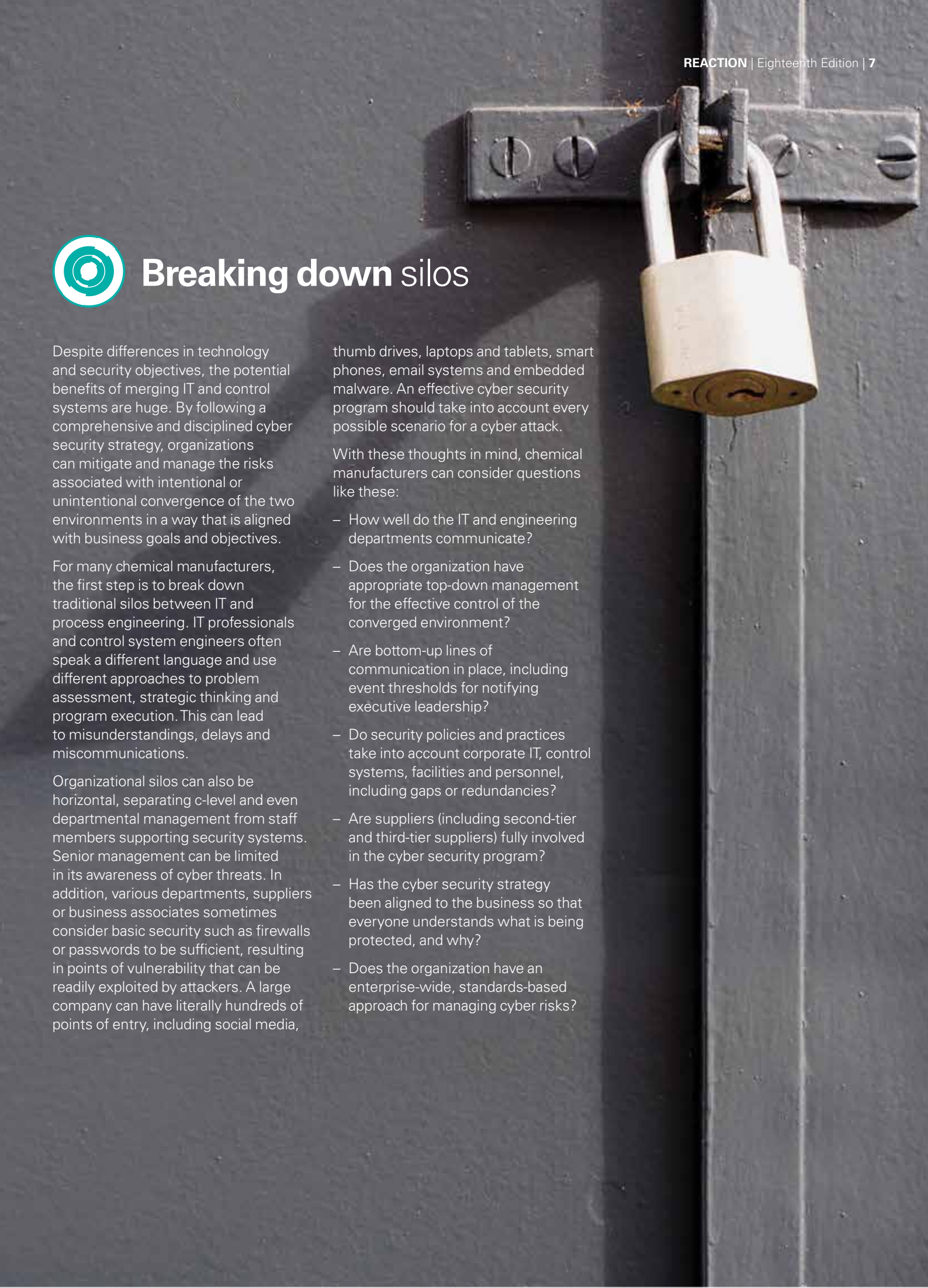
A comprehensive strategy for cyber security needs to recognize the basic fact that control system security is not the same as corporate IT security. In fact, each side has different security objectives, a different technology background, and a different approach to managing security issues and technology issues in general.

IT systems are business systems whose primary cyber security objective is to protect data from being stolen, destroyed, compromised or examined by unauthorized parties. The software applications that make up the IT portfolio are people-centric and designed to help manage business processes and transactions. Traditionally, the IT world leverages de facto technology standards and adapts quickly to new and various computing trends in information sharing and communication.

In contrast, a control system is engineered to maintain the integrity of its production process and the availability of its components. Control system networks can be viewed as industrial intranets with two overriding security requirements: 1) no access to the internet or to email should be allowed from control system networks and 2) these networks should be rigorously defended from other plant networks, especially those with internet access. Protection of information is still important, but loss of production translates into an immediate loss of income. Threats to production integrity include those that degrade production, cause loss of view/control, damage production equipment or result in possible safety issues.

Control systems can include safety instrumented systems (SISs) designed to place the production process into a safe state when process conditions that threaten safety are detected. In addition, control system networks that connect control system workstations with controller-level devices are normally redundant to prevent a network failure from affecting the operation of the control system. In both cases, this technology is typically proprietary to the control system vendors, including specialized hardware and software, custom addressing models and switchover logic.

Because of the differences between IT environments and control systems, the tools and techniques that IT uses to maintain and protect its dynamic network topologies are often not suitable or applicable to statically defined control systems. For example, the lifespan of a typical control system can extend for years, so patches for many older systems may no longer be available or compatible with newer technology. All updates, including patches and virus definition files, should be thoroughly tested with the control system before being approved for installation.



Breaking down silos

Despite differences in technology and security objectives, the potential benefits of merging IT and control systems are huge. By following a comprehensive and disciplined cyber security strategy, organizations can mitigate and manage the risks associated with intentional or unintentional convergence of the two environments in a way that is aligned with business goals and objectives.

For many chemical manufacturers, the first step is to break down traditional silos between IT and process engineering. IT professionals and control system engineers often speak a different language and use different approaches to problem assessment, strategic thinking and program execution. This can lead to misunderstandings, delays and miscommunications.

Organizational silos can also be horizontal, separating c-level and even departmental management from staff members supporting security systems. Senior management can be limited in its awareness of cyber threats. In addition, various departments, suppliers or business associates sometimes consider basic security such as firewalls or passwords to be sufficient, resulting in points of vulnerability that can be readily exploited by attackers. A large company can have literally hundreds of points of entry, including social media, thumb drives, laptops and tablets, smart phones, email systems and embedded malware. An effective cyber security program should take into account every possible scenario for a cyber attack.

With these thoughts in mind, chemical manufacturers can consider questions like these:

- How well do the IT and engineering departments communicate?
- Does the organization have appropriate top-down management for the effective control of the converged environment?
- Are bottom-up lines of communication in place, including event thresholds for notifying executive leadership?
- Do security policies and practices take into account corporate IT, control systems, facilities and personnel, including gaps or redundancies?
- Are suppliers (including second-tier and third-tier suppliers) fully involved in the cyber security program?
- Has the cyber security strategy been aligned to the business so that everyone understands what is being protected, and why?
- Does the organization have an enterprise-wide, standards-based approach for managing cyber risks?

A strategic, collaborative approach to security

Although every organization is different in its security requirements, a strategic approach based on the efforts of stakeholders across departments, business units and parties outside the organization can serve as a strong foundation for control system security. This approach can be broken down into the following key phases:

Developing a foundation

Develop a control system cyber security strategy that is based on solid foundations that are aligned to the organization's culture, environment and business strategy. This starts by identifying all key stakeholders and securing their full cooperation with the security goals of the organization. Working together, stakeholders can identify gaps and develop the appropriate governance mechanisms to manage and control all aspects of control system cyber security.

Planning and control

Build the capabilities to prioritize, coordinate and measure the work to improve security. Then review and design the extended risk and control environment for the control system assets. In particular, look at the risk management regime and ensure that it is appropriate for the control system environment.

Implementation

Design and implement appropriate methods that allow processes to operate with a level of cyber risk that is as low as reasonably practical. Cyber threats are always rapidly evolving, so incorporate a review process that includes regular assessments and upgrades of security measures.

> "Develop a control system **cyber security strategy** that is based on solid foundations that are aligned to the **organization's culture, environment** and **business strategy**."

Conclusion

In a recent survey by KPMG in the UK, 80 percent of respondents surveyed said they already have merged, or are planning to merge, their production and corporate IT systems.[7] However, two-thirds of the respondents said their organization had not factored in the significant threat that cyber criminals pose to their industrial control systems and almost half stated that their businesses were not investing enough to improve cyber security.

Cyber security will remain a critical issue for the chemical industry. Bad actors are nothing new; the difference today is how and why they act. Organizations can take an inclusive, coordinated and strategic approach to planning, vigilance and ongoing enhancements to help them manage and mitigate cyber risks.

[7] Growing tide of IT integration in the UK is leaving critical sectors exposed to cyber threats, warns KPMG study, KPMG press release, August 2015

Authors

Tom Burton
Cyber Security Director
KPMG in the UK
T: +44 20 7694 1191
E: tom.burton@kpmg.co.uk

Tom has over 25 years of experience in security and intelligence. Having focused, during the first half of his career, on using information for competitive advantage within the enterprise, he now advises clients on how to prevent their adversaries from doing that from outside.

Roy Mcnamara
Cyber Service Development
KPMG in the UK
T: +44 20 7311 5089
E: roy.mcnamara@kpmg.co.uk

Roy is a governance, risk, security and process control specialist with a broad set of skills and experience gained across multiple sectors including Energy, Healthcare, Government, CFMG and Financial Services. He is able to effectively bring together technology and business teams in order to execute change.

Cash is always king:

how chemical companies are optimizing their working capital

By **Andrew Ashby, Daniel Broadhurst** and **Nathan McCarthy**

During the global downturn, working capital management was top of mind for the chemical industry. Companies were able to unlock cash and improve their balance sheets through rigorous working capital management. With today's increased revenues, falling raw material prices and ready access to cheap debt, companies might feel that they have fewer incentives to change their processes. However, opportunities are often available to improve capital performance, and the benefits can range well beyond increased liquidity. Whether in good times or bad, working capital management should be based on holistic, sustainable solutions and should be an intrinsic part of a chemical company's business strategy.

Maintaining cash discipline

Faced with economic upheavals beginning in 2008, chemical companies acted aggressively – and in many cases, successfully – to reduce the cash level between what they had purchased (inventory and accounts payable) and what they had sold (accounts receivable).

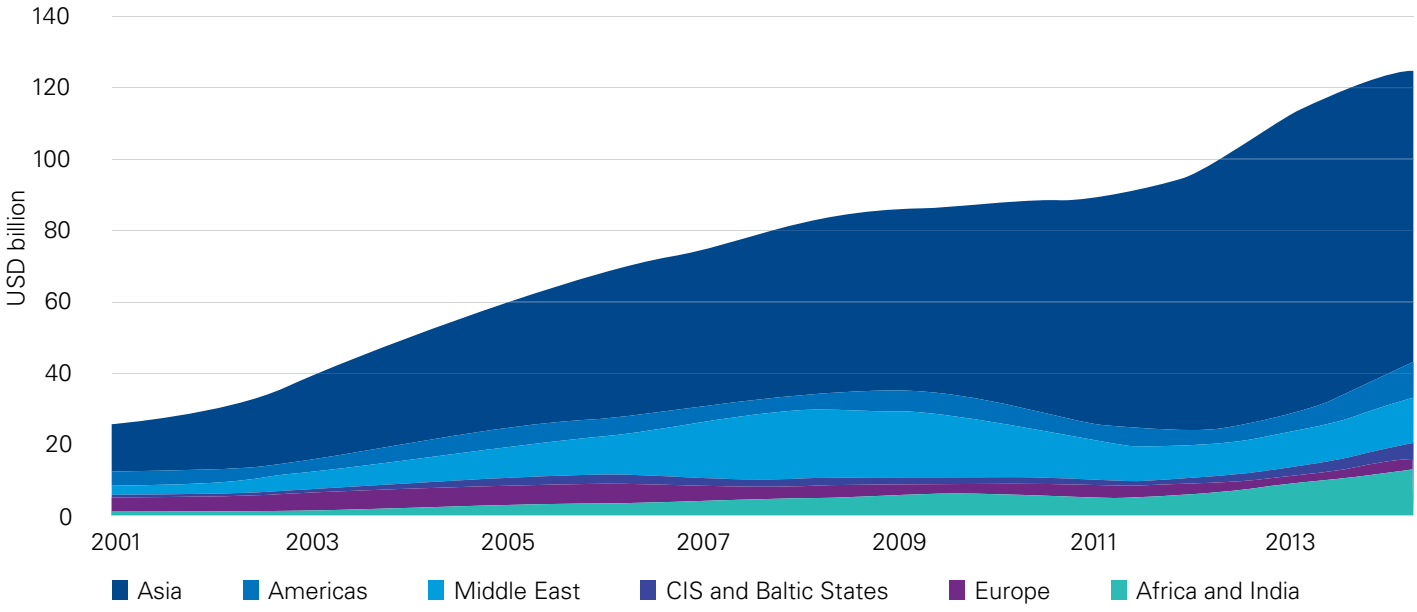
By most measures economic times have improved. Revenue growth for the chemical industry is expected across all regions, including over 3 percent in North America and almost 5 percent in emerging markets, and this growth is likely to continue into 2016.[8]

In addition, interest rates have dropped to historically low levels and credit markets are relatively accessible.

Driven in part by these positive trends, many companies have adjusted their efforts in maintaining cash discipline. According to a recent survey of large US companies, cash on hand has increased 74 percent since 2007.[9] In research conducted by KPMG across several business cycles, evidence suggests that working capital performance by companies tends to follow the economy in general – improving during hard times and declining in recovery years.[10]

Capital expenditures – chemical industry

Regional spending



Source: IHS Chemical Capital Cost Prospectus, IHS Chemical

[8] Projected revenue growth rates of the global chemical industry from 2015 to 2018, by region, Statista, www.statista.com/statistics/398351/prediction-of-chemical-industry-cagr-worldwide-by-region/. See also American Chemistry Council's (ACC), Mid-Year 2015 Chemical Industry Situation and Outlook, June 2015

[9] 2015 REL Working Capital Survey. See also Barely Working, CFO magazine, 11 June 2015, http://ww2.cfo.com/cash-management/2015/06/barely-working-capital/

[10] Cash: Part of a healthy corporate lifestyle, KPMG cash and working capital management survey report 2011

A plan for all seasons

For chemical companies, effective cash and working capital management should be a consistent part of business as usual – not an emergency plan reserved only for economic downturns or financial stress within the company.

By its nature, chemical manufacturing is capital intensive, so companies should always manage this capital as efficiently as possible. The global chemical industry will spend more than 2 trillion US dollars (USD) over the next 20 years.[11] Building and maintaining manufacturing facilities takes enormous amounts of capital. The same applies to storage facilities and transportation systems, including environmental safeguards required by regulators. Inventory will always contain a significant amount of capital, even with diligent efforts to streamline the supply chain.

Chemical manufacturing is also part of a cyclical and ever-changing industry. Even in the US, where low feedstock prices and strong domestic markets have boosted revenues, chemical companies recognize that these same advantages can lead to reduced oil and gas production, a downward pressure on product prices, and manufacturing overcapacity when demand slacks off.

Other uncertainties involve a change in interest rates triggered by government policies or banking systems, new directions in the Chinese economy, investor activism targeting chemical companies, and geopolitical realignments in the Middle East. Unforeseen events like these can have a ripple effect across countries, regions, supply chains and industrial sectors, impacting chemical companies at multiple levels. The best approach for cash and working capital management is to always 'hope for the best but plan for the worst.'

Developing a cash culture

The mark of a well-run business is a cash culture based on effective working capital management. Unlocking cash is always cheaper than borrowing and less disruptive than selling assets. This cash can be used to fund new growth, retire debt, gain price discounts on cash purchases, benefit from a top commercial credit rating, and take advantage of market opportunities.

Greater transparency is another important benefit. Working capital levels can be hard to see. The performance of a business is usually evaluated on income statement measures such as EBITDA or earnings per share, and these metrics are not driven directly by a company's level of working capital. At the same time, companies might not systematically track data on working capital, or consolidate data across suppliers, business units, divisions or functions. However, managers should always know how many days their current inventory will last at each location and stage of production – from feedstocks to processing to finished products. They also need to know how much they spend with each supplier and their respective payment terms. Sometimes these figures are available to managers but sometimes not. Even if supplier contracts are renegotiated on a regular basis, they still might rely on outdated information.

A 'clean-sheet,' zero-based assessment based on accurate, timely data and rigorous analysis can lead to a better understanding of capital levels that can, in turn, reveal waste and inefficiencies. The assessment can also provide managers with a more informed understanding of supply chain and operational processes. Discovering, for example, that two divisions use the same supplier might open the door to negotiations involving volume-based pricing and extended payment terms.

As always, the goal should be to make working capital management a key part of a healthy cash culture. Managers with budget responsibilities need to understand the implications of their actions and balance these with the priorities of the business to achieve the best outcome.

[11] IHS Chemical Capital Cost Prospectus, IHS Chemical, www.ihs.com/pdf/IHS-Chemical-Capital-Cost-Prospectus_223215110913060132.pdf

Optimized, not just minimized

Working capital management is more than just a matter of squeezing out cash. Working capital must be optimized across the organization, not just minimized — too much inventory traps cash, but too little inventory can hamper the response to customer orders. Inventory levels and revenues may or may not move up and down in concert; a 30 percent revenue growth might require a 50 percent increase in inventory, or vice versa.

More important for working capital management is a holistic strategy that aligns itself with the specific business model and objectives of the company. A manufacturer in South America serving markets in China will always have a certain level of inventory on the water, a fact that needs to be reflected in its capital strategy. A manufacturer preparing to enter emerging markets in Southeast Asia might want additional cash to finance new ventures, supply chains and distribution networks over a large region. A company in particularly volatile or cyclical markets might want to increase inventory levels to cover unexpected demand even as costs rise or revenues dip.

This holistic strategy should be developed by stakeholders across the enterprise. Although finance usually takes the lead, target setting should be a collaborative process that involves procurement (for accounts payable), manufacturing (including inventory) and sales (for accounts receivable). Inventory levels should be determined by multiple divisions that share their information to help optimize production schedules and stock levels. Experience based on KPMG member firm engagements has shown that companies with a good sales and manufacturing relationship generally benefit from a more efficient supply chain and a better working-capital-to-revenue ratio.

Chemical companies should also explore other areas of cash and working capital management which is sometimes overlooked, such as indirect tax, pension funding and capex cash controls. Especially important are opportunities involving ways to link compensation incentives with cash management. If managers see a direct connection between their actions and compensation, they will be much more motivated to focus on working capital.

Strong frameworks for sustainability

Good working capital management is a matter of getting the basic things right – and then keeping them right. That is why chemical companies need to develop sustainable initiatives for cash and capital management based on a strong framework built on visibility, control, organization and capabilities.

The leadership team and board should provide active support with clear, consistent messaging about the importance of working capital management. Everyone should understand why change is needed and how solid benefits are achievable. Determining change should include a realistic assessment of what is possible and how success can be achieved.

Messaging should reflect proper governance, and both need to be executed according to plan, not shifting the emphasis, for example, from cost 1 year to cash the next. An organization-wide communications program can provide regular updates and guidance on capital management goals and activities. In particular, Accounts Payable, Accounts Receivable, Sales and Finance should be in close communication with one another and properly aligned in terms of their cash targets and strategies.

In addition, the framework should be flexible enough to accommodate today's complex organizations. Business units have different constraints, challenges and priorities, so targets should be tailored accordingly. Changes can be embedded through governance policy, training, contract templates, negotiation and other areas.

The right technology can also help play a key role in effective working capital management. Benefits include the rapid analysis and identification of opportunity areas, enhanced processes and ways of working, and improved transparency and reporting of cash and working capital across the organization. To give just one example, digital tools can enable real-time collaboration between buyers and suppliers to discover the optimal rate for early invoice payment. By allowing each supplier to offer the rate that makes sense for them at that point in time, the buyer captures a much broader range of discounts while providing its entire supply chain more flexibility on timing and frequency of usage.

Supporting a framework for sustainability is not a simple task. It requires ongoing tracking of strategic initiatives from c-level decisions to business unit activities. Volume-proofing tracking is also important. However, the results are worth the effort. Even medium-term improvements in working capital management can significantly mitigate the cost of other transformation activities.

"Business units have **different constraints, challenges** and **priorities**, so targets should be tailored accordingly. Changes can be embedded through **governance policy**, training, contract templates, **negotiation** and other areas."

USD2 billion in cash: a case study in working capital management

Challenge

A multi-billion dollar chemical company wanted to reduce working capital levels to increase available cash for strategic investments. A benchmarking exercise conducted in 2011 suggested that working capital investment of USD12 billion could be reduced by up to USD2 billion. Accordingly, a working capital optimization program was undertaken to free up cash.

Approach

Four workstreams were established to drive detailed, specific and complex working capital reduction initiatives. Focus areas included Inventory, Accounts Receivable, Accounts Payable, and Maintenance, Repair and Operations (MRO).

The program used a phased approach. Team members focused on a specific strategic business unit for 12 months before moving on to the next. Sophisticated benefit tracking tools with executive dashboards were designed and implemented for each phase, helping to achieve granular visibility over the delivery of benefits and to drive executive focus toward working capital improvement.

Policies and procedures were updated to reflect best practices, and maintenance plans were built to help reduce the risk of underperformance and ensure that sustainability challenges were swiftly addressed.

Outcome

Around USD2 billion of working capital improvement has been delivered, and an additional USD500 million is expected in the future. These results are based on a 17-day increase in the company's Cash Conversion Cycle (CCC) from 2009 to 2014. Days Sales Outstanding (DSO) has improved by 3 days, and Days Payable Outstanding (DPO) for the company currently sits within the fourth quartile of the peer group.

Expect the unexpected

CFOs, finance directors and other company leaders should keep in mind the wisdom of expecting the unexpected. In today's global economy, 'black swans' are not as rare as they were in the past. The effective management of cash and working capital can improve performance while managing risk. A holistic approach that emphasizes a sustainable cash culture will help chemical companies take better advantage of opportunities during the good times and prepare themselves against market contractions and fiscal downturns.

> "Around **USD2 billion** of working capital improvement has been delivered, and an additional **USD500 million** is expected in the future."

Authors

Andrew Ashby
Partner
KPMG in the UK
T: +44 20 73111335
E: andrew.ashby2@kpmg.co.uk

Andrew is a senior advisor within the UK Cash and Working Capital practice advising global companies on cash improvement programs.

Daniel Broadhurst
Director
KPMG in the UK
T: +44 20 7311 8288
E: daniel.broadhurst@kpmg.co.uk

Dan specializes in working capital optimization in global chemicals organizations, working side by side with his clients. The programs that he has worked on have delivered over USD2 billion of cash benefits across the chemicals sector.

Nathan McCarthy
Senior Manager
KPMG in the UK
T: +44 20 7694 1056
E: nathan.mccarthy@kpmg.co.uk

Nathan is a Senior Manager in the UK specializing in liquidity optimization. He works with global chemical organizations to deliver significant and sustainable working capital improvement. During his time spent within the chemicals sector he has operated out of three different continents and numerous different countries. His primary area of expertise is across the purchase-to-pay cycle with a detailed knowledge of how to optimize performance within different geographies, subsectors and cultures.

Korean chemical industry moves toward growth and diversity

By **Edward Kim** and **Farrah Lee**

The chemical industry in Korea is a case study in strength and resilience, not surprising in a country where the GDP has tripled every decade since the 1960s.[12] Even during the global recession, Korean chemical companies maintained impressive performance levels, based in large part on exports to China. However, this focus on Chinese markets also means that Korean chemical companies are now feeling the effects of China's slowing economic growth, the devaluation of the yuan and new government policies favoring chemical products made in China over imports. Further uncertainties arise from a high dependency on petrochemical production and downward price pressures due to low oil prices. Future growth will likely depend on a restructuring and consolidation of the industry, a shift away from basic petrochemicals and the pursuit of new opportunities in the specialty chemical sector.

[12] Best Countries for Business, Forbes, 2014, www.forbes.com/places/south-korea/. See also The Scorecard on Development, 1960–2010: Closing the Gap?, DESA Working Paper, 2011; IndexMundi, www.indexmundi.com/g/g.aspx?c=ks&v=66; and Korea: A Case for Government-led Development, Kihwan Kim and Danny M. Leipziger, 1993

Key facts about the Korean chemical industry[13]

5th largest global chemical producer

3rd largest Asian chemical producer

USD154.2 billion
in sales (2014)

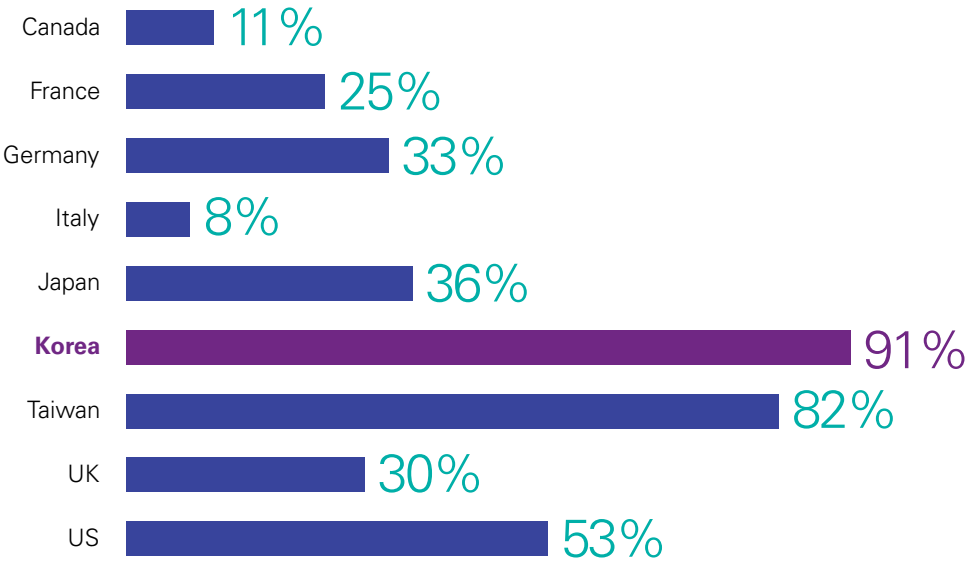
11.2%
annual growth rate of Korean chemicals 2005–2013

Capacity of major petrochemicals:
79.9 million
MTPA (2014)

Industry segments by capacity

Basic petrochemicals:	**37%**
Intermediates:	**21%**
Synthetic resins:	**17%**
Synthetic fiber raw materials:	**11%**
Synthetic rubber and other:	**14%**

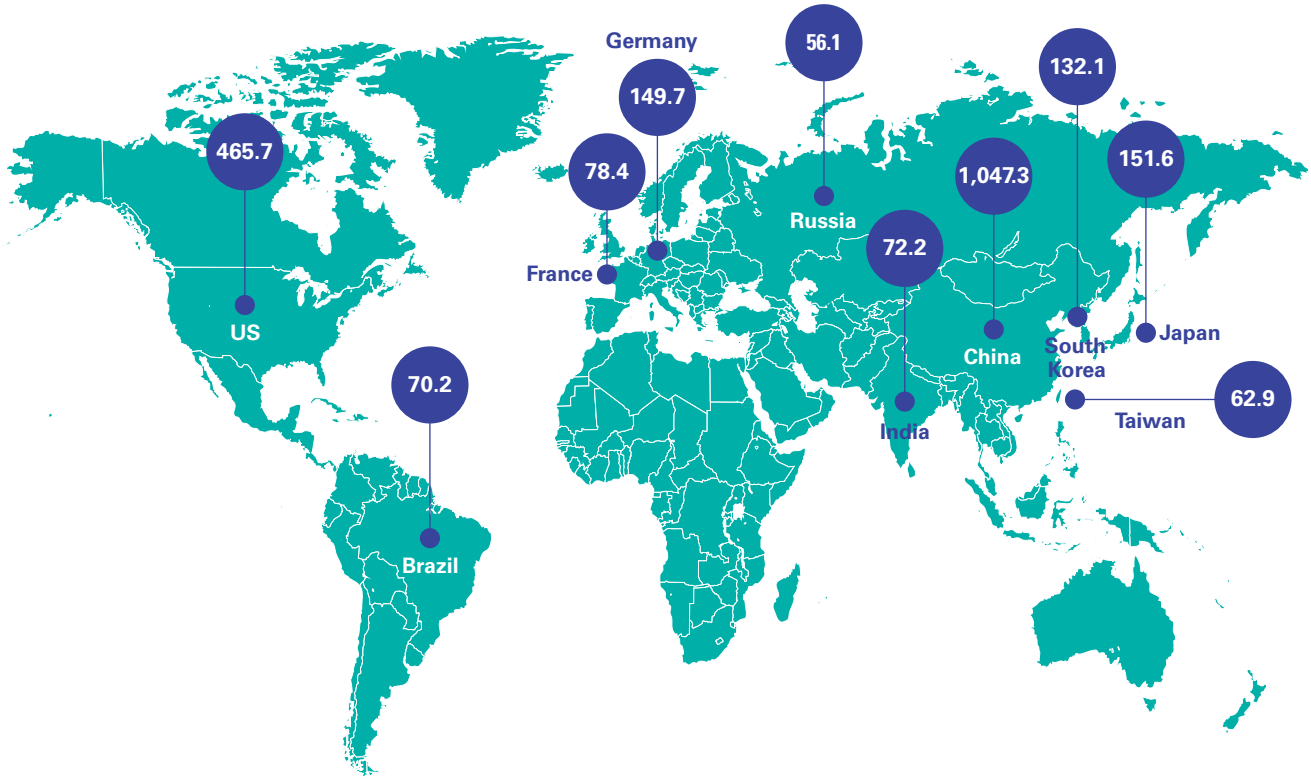
Korean manufacturing: labor productivity gains, 2002–2012



Source: The Conference Board, International Labor Comparison Program

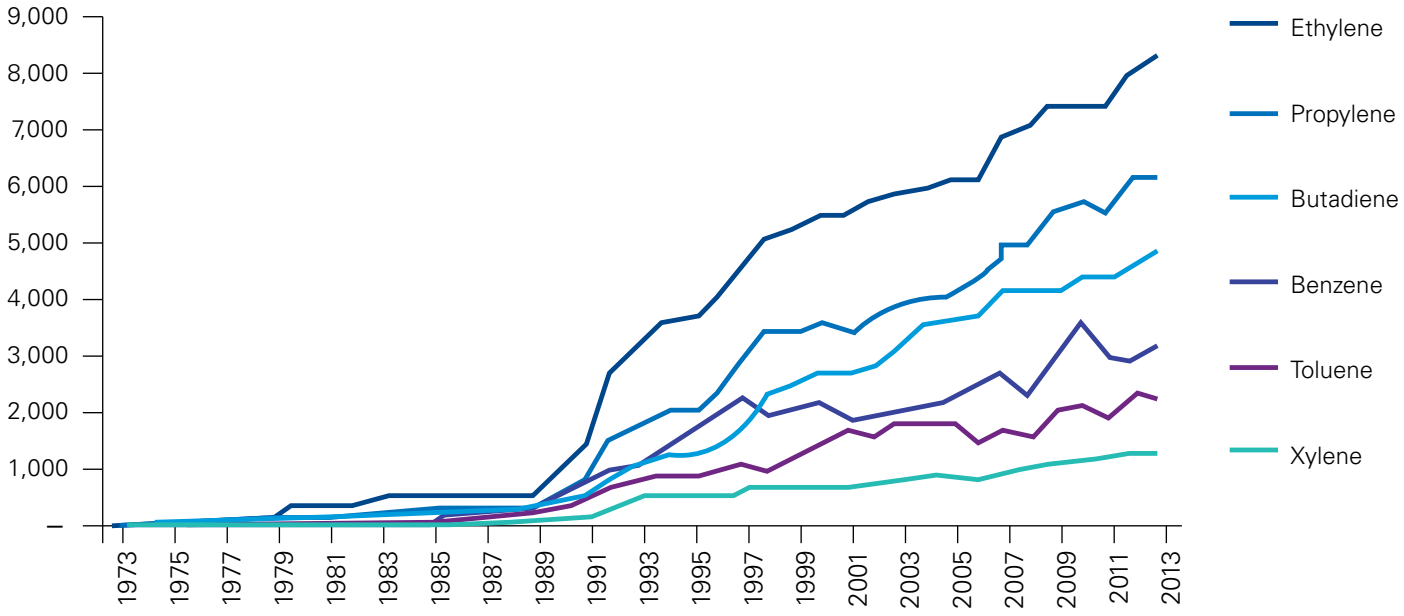
[13] The European Chemical Industry: Facts and Figures, Cefic, 2014; Invest Korea; Korea Petroleum Chemical Association; Korea Petrochemical Industry Association

Chemical sales 2013 (GBP billion)



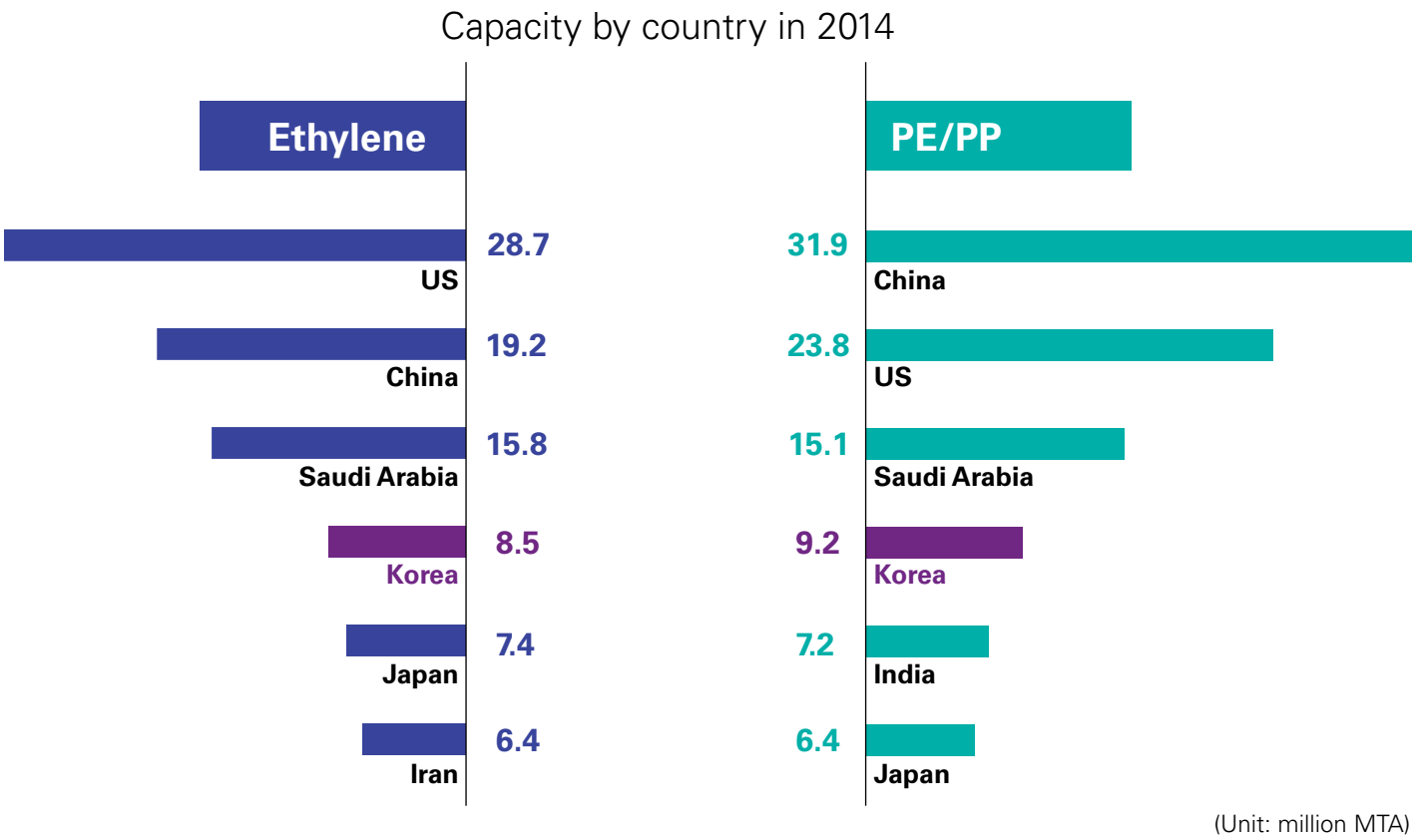
Source: Cefic Chemdata Inernational (2014)

Korean basic petrochemical production (in 1,000s of tons)



Source: Korea Petroleum Chemical Association

Korean petrochemical capacity



Source: Korea Petrochemical Industry Association

A major player in petrochemicals

'Compressed development' is a term often used to describe rapidly emerging economies, and it certainly applies to the Korean chemical industry. In many ways, the industry has compressed a century's worth of development into a few decades, and Korea is recognized today as the fifth largest chemical producer in the world and the third largest chemical producer in Asia.

Much of the development in the chemical sector is in line with the expansion of Korea's national economy. Over the past 6 decades, Korea has grown to become the world's thirteenth largest economy by GDP[14] and now ranks among the world's top 10 economies in terms of foreign reserves, exports and total trade.[15] Leading industries include information and communications technology (ICT), electronics, semiconductors, automobiles, construction, shipbuilding, steel production and petrochemicals. Home to global companies like Samsung and POSCO, Korea has developed key partnerships with 259 of the Fortune Global 500. The country has free trade agreements (FTAs) with 52 countries, and it is the only Asian country to have FTAs with both the European Union and the US.[16]

Korea's rigorous education system and the establishment of a highly motivated and educated populace has been a key driver for the country's rapid economic growth. Over 65 percent of Koreans between 25 and 34 have college degrees, the highest in the Organisation for Economic Co-operation and Development.[17]

Not surprisingly, the country is recognized as a global leader in innovation, ranking first among 215 countries on the Bloomberg Global Innovation Index.[18]

From 1966 to 1997, the chemical industry in Korea benefited from government-led, national economic development plans. Chief among these was the Declaration of Heavy and Chemical Industry (HCI) Policy in 1973.[19] This initiative was accompanied by legislation such as the Industrial Site Development of Promotion Law that also favored large manufacturers. Six strategic industries – including petrochemicals – were supported through a combination of tax incentives, subsidized credit and import protection. Domestic producers were encouraged to license foreign technologies.

Supported by these and other government measures, production from HCI industries between 1973 and 1983 grew 23 percent.[20]

Today, government development plans have been replaced by private sector activities, including mergers and acquisitions, increased foreign investments, and diversification into fine chemicals. Since 2005, annual growth has averaged a robust 11 percent.[21] The chemical industry is the third largest industry in Korea's manufacturing sector and one of the largest industries in the country, with total production valued at USD154.2 billion.

The largest segment – 36 percent – of the Korean chemical industry is represented by basic petrochemicals, including ethylene, propylene, Mixed C4, and BTX products such as benzene, toulene and xylene. Based on industry capacity for ethylene, polyethylene (PE) and polypropylene (PP), Korea ranks fourth in the world, surpassed only by China, the US and Saudi Arabia.[22] The country produces 8.5 million tons of ethylene annually.[23] This ethylene is used, in turn, to produce synthetic resins for plastic products, synthetic fiber raw materials for textiles, synthetic rubber, and other chemical-based products such as paints, detergents and adhesives.

> "The **chemical industry** is the **third largest industry in Korea's** manufacturing sector and one of the largest industries in the country, with **total production** valued at **USD154.2 billion**."

[14] IMF
[15] Investkorea.org (Bank of Korea)
[16] Ibid.
[17] Ibid.
[18] Bloomberg Global Innovation Index, January 2014
[19] Op. cit., Korea: A Case for Government-led Development
[20] Ibid.
[21] Korean Statistical Information Service
[22] Ibid.
[23] Ibid.

The advantages and risks of Chinese markets

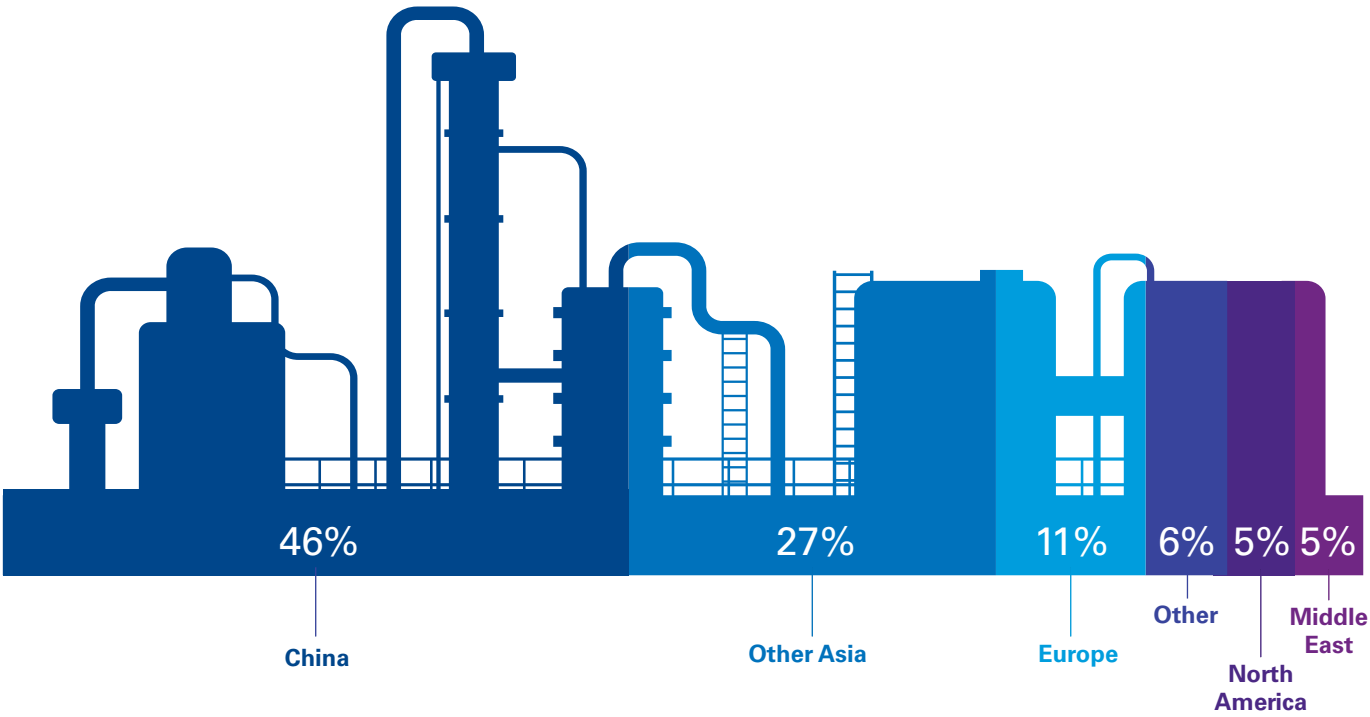
At the end of 2008, the Korean chemical industry braced itself, expecting a slump in revenues because of the global financial crisis. From 2008 to 2010, however, demand for Korean products remained relatively stable and in some cases actually increased. This was due almost entirely to China, which has traditionally been Korea's largest market for chemicals. In 1992, Chinese markets consumed 29.8 percent of Korean chemical exports. This figure rose to 43.6 percent in 2000 and approached 50 percent in 2014.[24] Three basic petrochemical products – ethylene, PE and PP – have accounted for about 80 percent of this trade over the past decade.

China's GDP was relatively unaffected by the Great Recession, remaining between 9 and 10 percent from 2008 to 2012.[25] During this time, chemical demand was fueled by a national policy that supported construction work for transportation infrastructure, agricultural development and residential construction. However, China's GDP growth rates have declined over the past 3 years, due in part to government policies designed to curb inflation and move the country toward the domestic consumption of retail goods made in China. By the middle of 2015, China's GDP growth had slowed to 6.8 percent.[26] According to KPMG analysis, China's GDP growth is expected to hover around 6.5 percent until 2020 due to changes in demographics, reduced exports because of a higher yuan and increased costs for labor.

The slowdown in the Chinese economy, changing government policies and the currency devaluation have dealt a major blow to Korean chemical companies. Korean basic petrochemical production declined 2.7 percent in 2014 and has only increased 0.9 percent for the first three quarters of 2015.[27] As of September 2015, petroleum product exports to China had dropped 40.3 percent year-over-year.[28] Production for synthetic resin has increased a mere 0.6 percent, while production for synthetic fiber raw materials and synthetic rubber has decreased dramatically.[29]

China is the second-largest consumer of basic chemicals after the US,[30] and Korea still exports significant amounts of chemicals to China. However, recent developments have increased the risk of depending on China as Korea's largest trading partner.

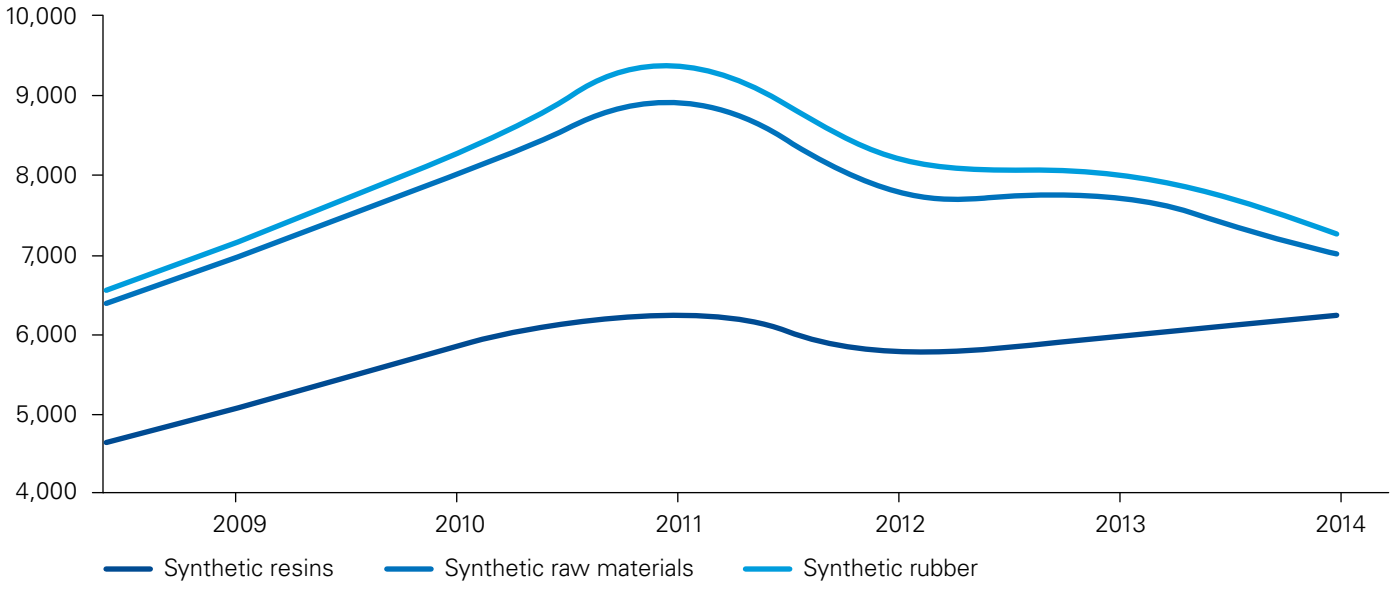
Korean petrochemical exports by region (2014)



Source: Korea International Trade Association

[24] Korea International Trade Association
[25] China National Bureau of Statistics
[26] EIU Economic and Commodity Forecast, July 2015, knoema.com/loqqwx/china-gdp-growth-forecast-2015-2020-and-up-to-2060-data-and-charts
[27] Korea Petrochemical Industry Association, www.kpia.or.kr/eng/industry/pcind_01.html
[28] South Korea exports plunge 14.7%, Financial Times, 1 September 2015
[29] Op. cit., Korea Petrochemical Industry Association
[30] The Chemical and Pharmaceutical Industry of China, www.chinese-champions.com/chemicalpharmaceutical/

Top three Korean chemical products exported to China (in USD millions)



Source: Korea International Trade Association

Squeezed by petroleum prices

Korea is not an oil-producing nation, and Korean chemical companies import virtually all their raw materials, mainly crude oil from the Middle East. Crude oil and refined oil account for almost a quarter of the country's imports.[31]

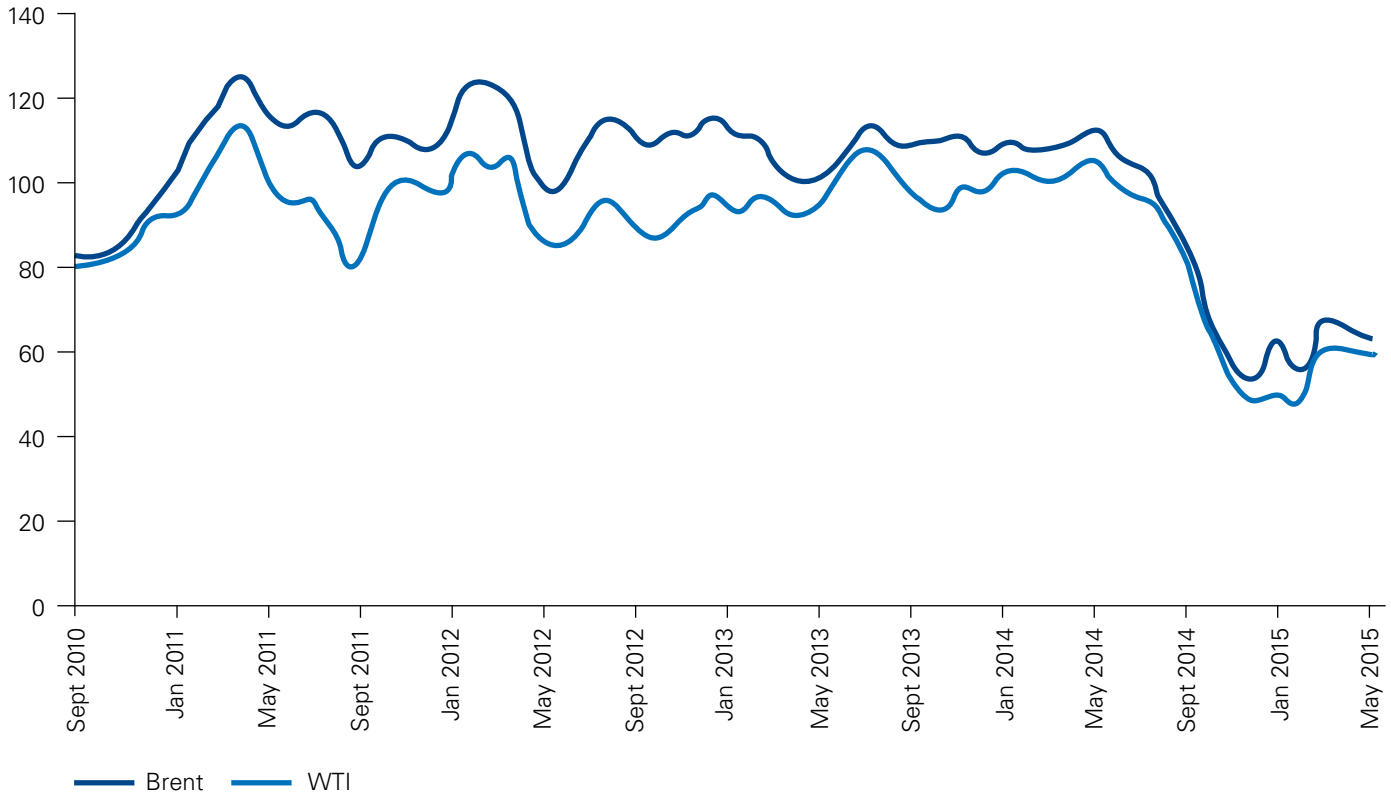
Naphtha, which is used for the country's sizeable petrochemical and industrial sectors, accounts for about 44 percent of total oil product demand and is the primary driver of domestic demand growth.[32]

With the drop in crude oil prices beginning in 2014, Korean chemical companies have seen a corresponding decrease in production costs. Analysis suggests that a 10 percent decline in oil prices can lead to a 2.02 percent drop in production costs for Korean petrochemicals.[33] At the same time, lower costs encourage lower product prices in the market, and this has been the case for Korea and other Asian chemical industries.[34] Furthermore, given the expectation of a decreased sales price, many consumers are delaying purchases, which places a burden on inventory and encourages even lower prices.

Through most of 2015, the price of a barrel of crude oil has remained at or below USD50/barrel[35] and significant price increases are not expected in the near future. Some analysts argue that lower oil prices should fuel stronger overall GDP growth and the potential for greater product substitution because lower feedstock prices can make chemicals more cost competitive relative to competing materials.[36] Nevertheless, current low prices for raw materials will remain a challenge in the near term for Korean chemical companies.

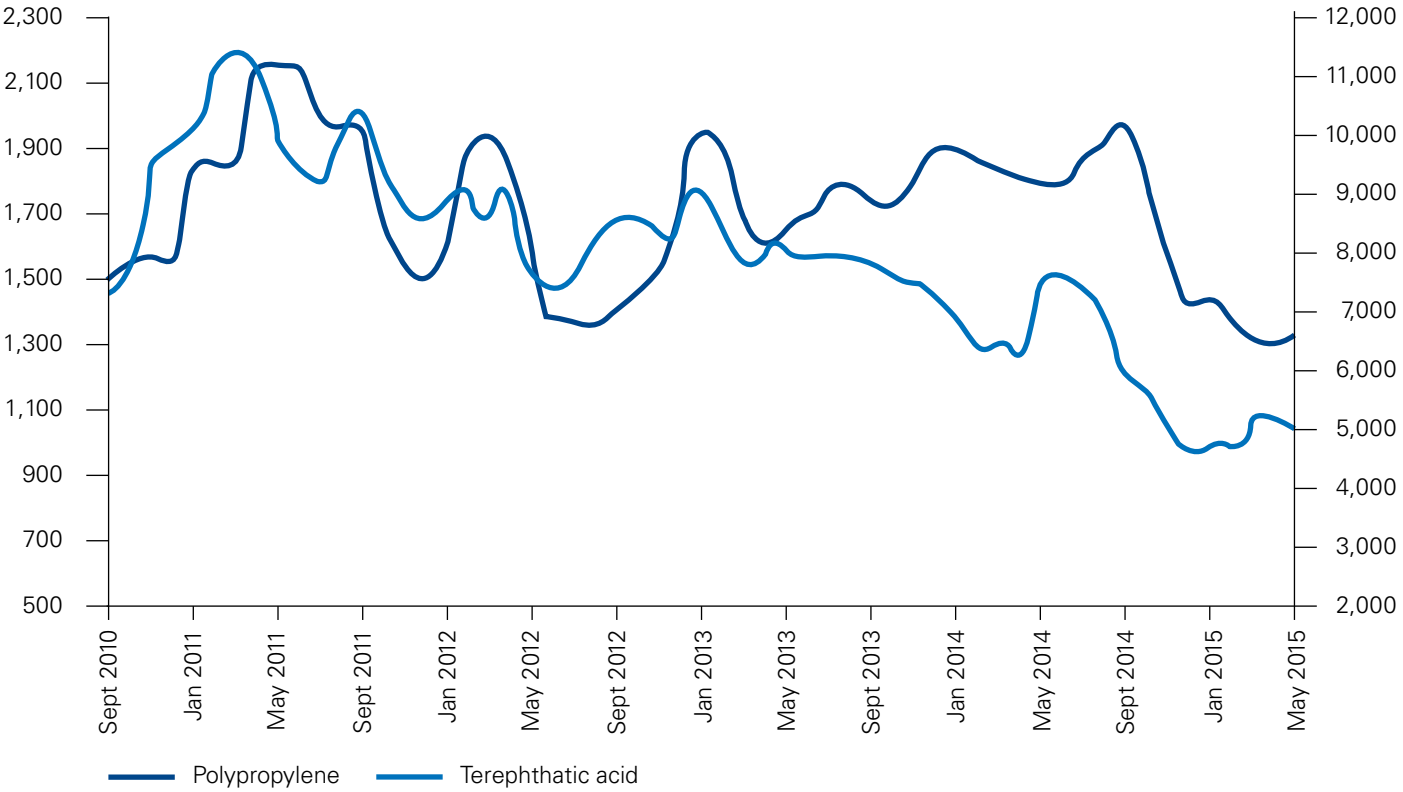
[31] Observatory of Economic Complexity, https://atlas.media.mit.edu/en/profile/country/kor/
[32] US Energy Information Administration, www.eia.gov/beta/international/analysis.cfm?iso=KOR
[33] Korea Development Institute, Korea Institute for Industrial Economics & Trade, Korea Institute of Finance, Korea Energy Economics Institute, and Korea Institute International Economic Policy, 7 January 2015
[34] Asian chemical prices following crude oil's slide, Nikkei Asian Review, 18 December 2014
[35] Oil-Price.Net, accessed 17 September 2015
[36] 2015 Forecast: Can demand shrug off crude price shock?, IHS ChemWeek, 12 January 2015

Price of crude oil (USD/BBL)



Source: Bloomberg, PVM Oil Associates and Saudi Aramco

Price of basic petrochemicals (in USD/MT and CNY/MT)



* Polypropylene – US Index, TPA – China Index

Source: Bloomberg, Nexant and Zhengzhou Commodity Exchange

New directions for a maturing industry

Over the past 50 years, the Korean chemical industry has seen great success with an efficiency-driven business model. Chinese demand and aggressive capital investment have achieved economies of scale through mass production of commodity products and the introduction of the latest equipment and facilities operations.

Current events suggest that 2015 may indeed mark a turning point for the nation's chemical companies. The country faces fierce competition from its neighbors, margins are shrinking on bulk chemicals, and even with low oil prices, the production cost of energy in Korea is much higher than in China and other Asian countries, thereby reducing Korea's competitive advantage.

In the next few years, Korea's chemical industry will transition from exporting commodity products to manufacturing specialty materials for both domestic and foreign markets. In the process, the Korean industry will likely undergo massive restructuring and consolidation, leaving only major companies and plants. It is reported that Lotte Group will acquire Samsung Group's chemical businesses for more than 3 trillion South Korean won (WON) (USD2.6 billion).[37] The companies that remain will seek new business opportunities further up the value chain, especially in the area of environment-friendly products developed through increased levels of R&D.

A number of Korean chemical companies have already begun the move to specialty chemicals to gain competitive advantage. LG Chemical began investing in batteries in the late 1990s. Today, the company is Korea's leading manufacturer of advanced batteries and a leading supplier of lithium-ion batteries. In 2014, LG Chemical began construction of an electric car battery plant in Nanjing, China, to meet the growing demand in the world's largest car market. The Nanjing battery plant is expected to have an annual production capacity of more than 100,000 units, supplying batteries to Chinese automakers like SAIC Motor Corp, Qoros and other global carmakers in China. The future strategy of LG Chemicals is based partly on developing synergies among its business units and affiliates. For example, LG Chemical's battery division, LG Electronics, LG Display, LG Innotek and LG Hausys Automotive Materials produce a variety of automotive products including batteries, infotainment components, displays and sensors.

Backed by a strong, long-term commitment to the solar industry, Hanwha Chemical has become a global leader in developing high-quality polysilicon, a key material used for photovoltaic (PV) solar panels. In 2014, the company announced a merger with Q CELLS to make it the world's largest manufacturer of solar cells, with a manufacturing capacity of 3.28 gigawatts.[38] In the same year, Hanwha bought plastics and chemicals assets from Samsung, making it the largest petrochemical firm in Korea.[39] In 2015, Hanwha and Saudi International Petrochemical opened a USD40 million thin-film solar panel manufacturing plant in Saudi Arabia. The facility will have an annual capacity of 4,000 metric tons of ethylene-vinyl acetate film when fully commercialized.[40]

Cheil Jedang (CJ) has recently emerged as Korea's leader in the food and beverage market, and the company may become one of the country's future leaders in the chemical industry. CJ manufactures a variety of bioscience products, such as MSG, nucleotides, lysine, threonine and tryptophan, and supplies them to the Korean and international markets. By expanding global production sites, improving R&D, increasing production competency and targeting global customers all over the world, CJ is now ranked number one in nucleotides and number two in lysine products.

[37] Samsung Group sells chemical assets to Lotte Group for $2.6 bln, Reuters, 30 October 2015
[38] Hanwha SolarOne and Q CELLS Announce Merger to Create New Solar Power Leader, company press release, 8 December 2014
[39] Sipchem, Hanwha open solar film plant in Saudi Arabia, Plastics News, 6 January 2015
[40] Ibid.

Conclusion

In light of the recent downturn in the Korean chemical industry, Korean companies will need to pursue a focus on new product development in advanced technological areas and changes in business models that can drive operating efficiencies. Further collaboration with foreign multinationals will be required, sharing domestic production facilities to reduce costs and entering into joint ventures with companies that offer proprietary technology in growth sectors such as semiconductors and electric car products. Korean companies will also need to reduce their reliance on Chinese markets by pursuing greater access for Korean products in other overseas markets.

The Korean chemical industry enjoys many advantages including a high technological base and strong domestic manufacturing and consumer demand, but the inexorable growth of demand from nearby China has provided easy access to growth and profitability for even the most inefficient of producers. Now that the Chinese growth story is slowing, the most successful Korean chemical companies will be those that adapt to the challenges of driving cost and process efficiency; technological product development; and international growth through expansion and partnering.

See our previous editions of REACTION for information on global growth opportunities:

Issue 17, *Gas-powered growth continues for US chemical companies*

Issue 15, Emerging chemical markets: What's next?: *Sustainable, long-term growth expected for China chemicals, ASEAN: the next chemical industry growth engine and A changing industry for India's chemical companies*

Issue 12, *China's chemical industry: the emergence of local champions*

Authors

Edward Kim
Head, Economic Research Institute
KPMG in Korea
T: +82 2 2112 0770
E: edwardkim@kr.kpmg.com

Edward has over 28 years of advisory and audit experience at KPMG, both in Korea and Australia. He specializes in transaction services and management consulting for multinational enterprises.

Farrah Lee
Manager, Economic Research Institute
KPMG in Korea

Farrah is a manager in the Economic Research Institute with KPMG in Korea. She specializes in market research and enterprise strategic analysis in the manufacturing industries.

KPMG in the industry

China site visits

Mike Shannon, Paul Harnick, Norbert Meyring and Tom Bailey recently went on site visits in China to discuss current thoughts within the chemicals industry today. We'd like to thank our hosts for their hospitality.

11th Annual Chemicals Wine Dinner, Shanghai

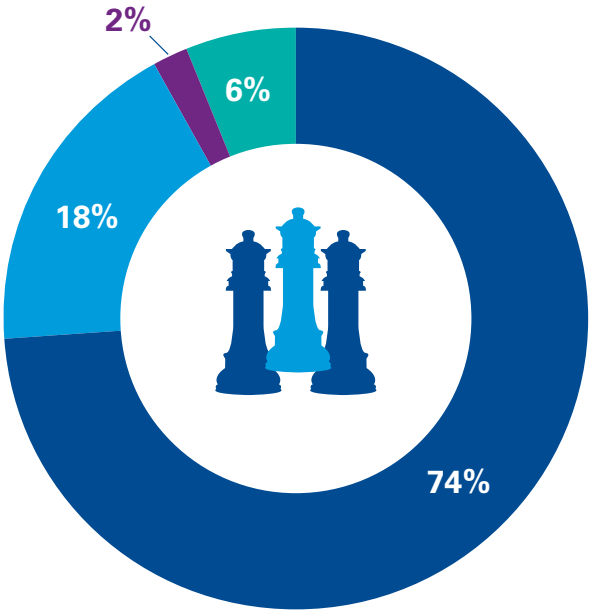
More than 30 senior executives from leading chemical companies attended the 11th Annual Chemical Sector Wine Tasting and Networking Dinner in Shanghai. This long-standing event always attracts top management from across China to gather and discuss current events and issues in an informal setting. Once again, Mike Shannon Paul Harnick and Tom Bailey joined Norbert Meyring to bring an international perspective to complement the local knowledge of KPMG China.

REACTION 17 webcast highlights

During our REACTION 17 webcast, we discussed what the recent fall in the oil price means for the shale boom, as well as how activist investor pressure is affecting business strategy in many companies across the industry.

Throughout the webcast, participants provided their feedback on key industry issues with the results shown below.

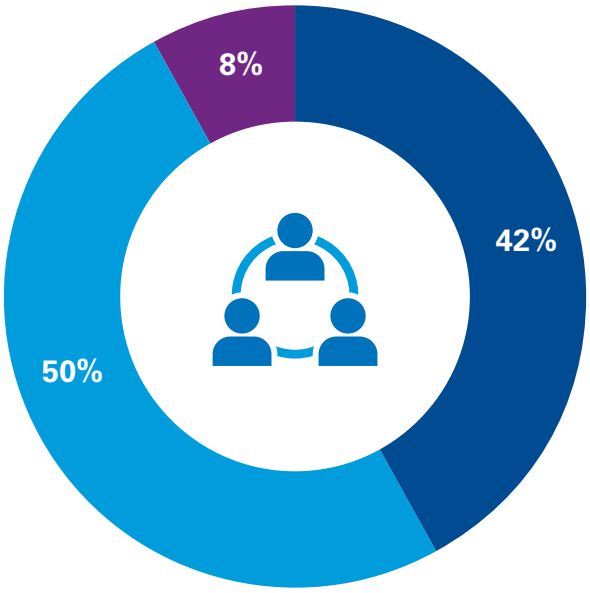
To what extent have shale dynamics changed the strategic importance of the US in terms of your overall business strategy?



- Increased the importance of the US
- Changed the way we think about the competitive environment
- Decreased the importance of the US
- No impact on business strategy

Number of respondents = 50*

In your business modeling, what is your mid-year 2016 outlook for global oil prices?

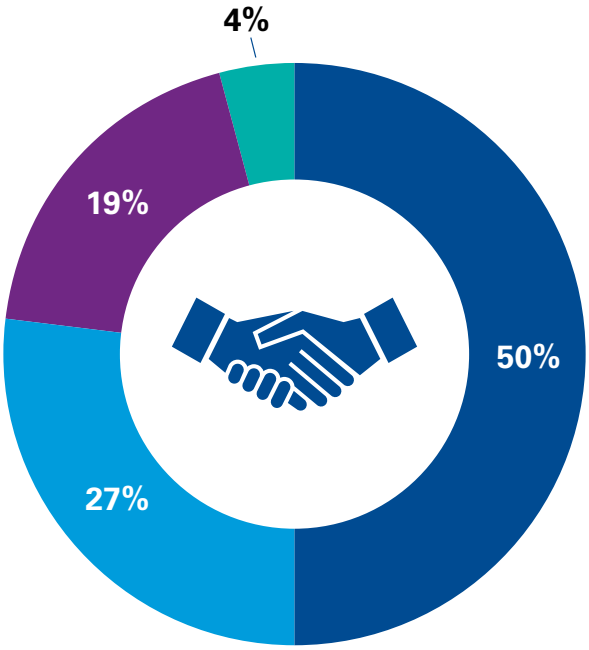


- USD50 bbl or less
- USD50 – USD70 bbl
- USD70 – USD90 bbl

Number of respondents = 52*

*Source: The US chemicals industry in 2015, Global Chemicals Institute webcast, KPMG International

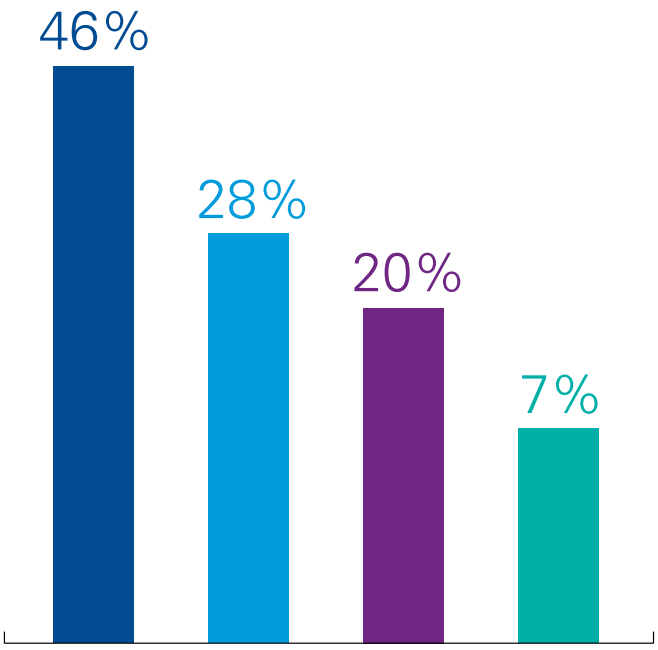
Why do you believe M&A activity in the sector has been limited recently?



- Concerns about strength of the global economy
- Valuations too high
- Shortage of suitable targets
- Lack of management/board strategic vision

Number of respondents = 52*

How do you view investor activism in the chemical sector?**



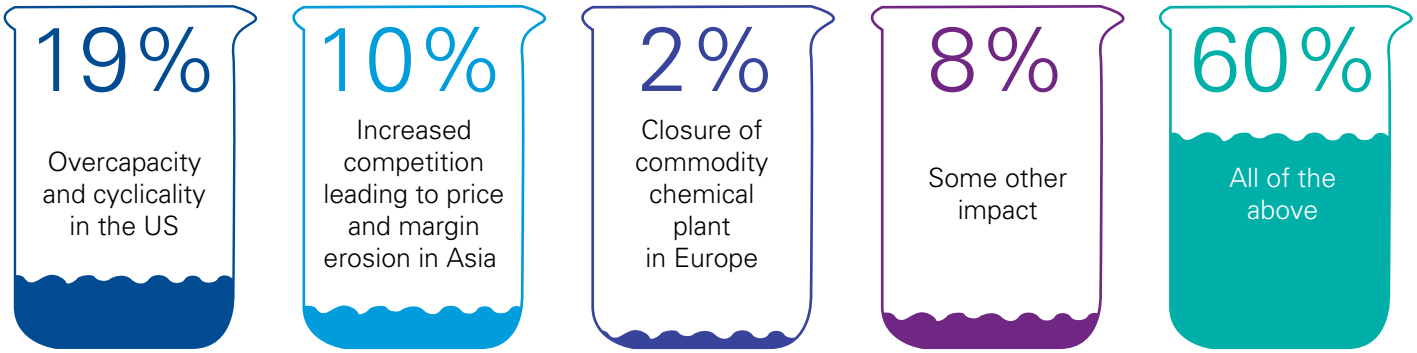
- A valuable challenge to business strategy (even if value impact unclear)
- A needless distraction for management teams
- A positive for shareholder value
- A negative for shareholder value

Number of respondents = 46*

*Source: The US chemicals industry in 2015, Global Chemicals Institute webcast, KPMG International

**Note: Percentages might not add up to 100% due to rounding.

What do you believe will be the biggest impact from growth in the US chemical industry?**



Number of respondents = 48*

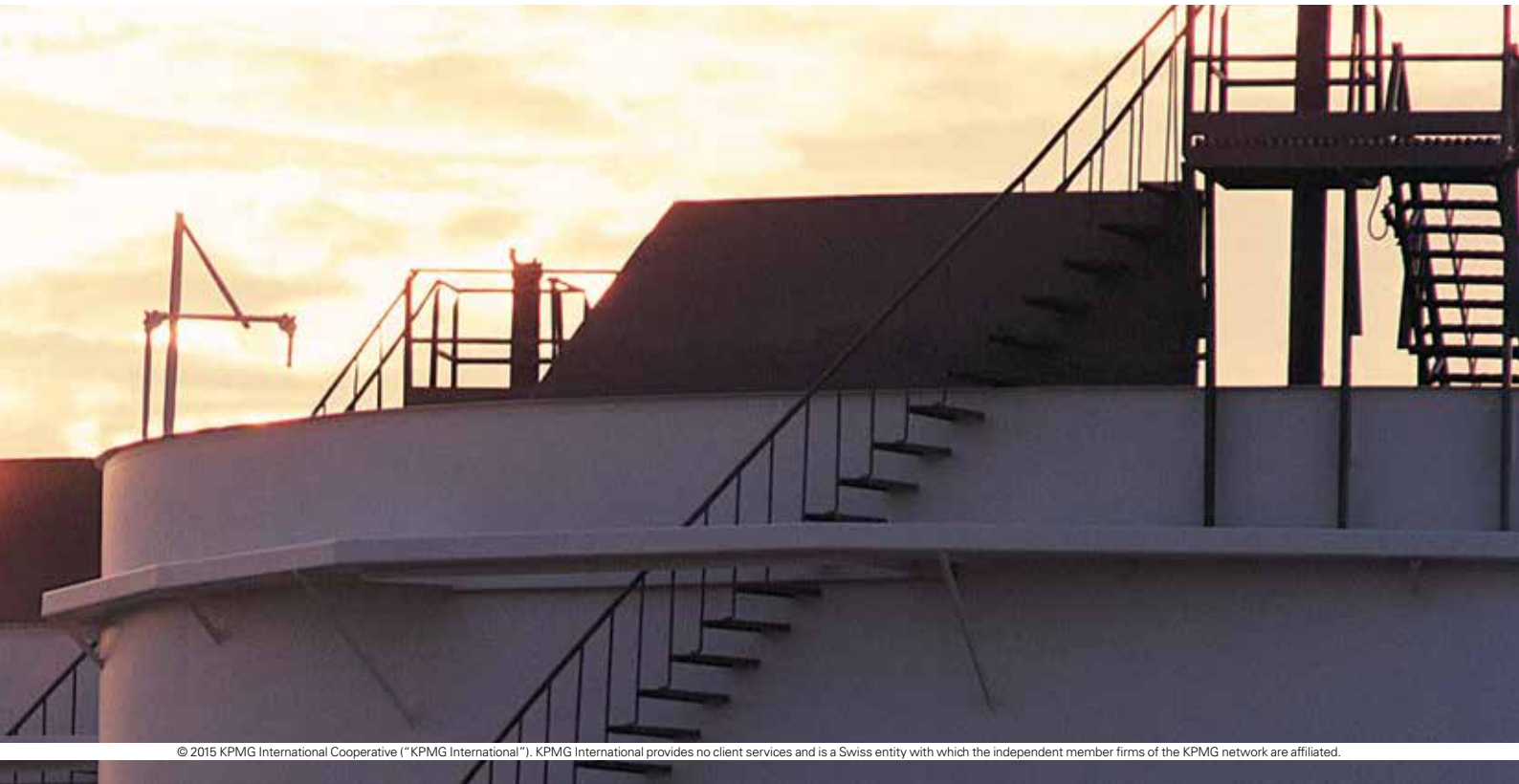
*Source: The US chemicals industry in 2015, Global Chemicals Institute webcast, KPMG International

**Note: Percentages might not add up to 100% due to rounding.

KPMG Global Chemicals Institute

Look for our upcoming REACTION 18 webcast, which will be taking place February 2016. Join our Global Chemicals Institute for access to valuable thought leadership and webcasts on key industry topics.

Visit **kpmg.com/chemicals** for more information and to register.



Contacts

Mike Shannon
Global Head of Chemicals and Performance Technologies
T: +1 973 912 6312
E: mshannon@kpmg.com

Steve Tonner
KPMG Australia
T: +61 (3) 9288 5377
E: stonner@kpmg.com.au

Anselmo Macedo
KPMG in Brazil
T: +55 11 2183 3152
E: amacedo@kpmg.com.br

Robert Jolicoeur
KPMG in Canada
T: +1 416 777 3733
E: bjolicoeur@kpmg.ca

Norbert Meyring
KPMG in China
T: +86 (0)21 2212 2707
E: norbert.meyring@kpmg.com.cn

Wilfrid Lauriano do Rego
KPMG in France
T: +33 1 55 68 68 72
E: wlaurianodorego@kpmg.fr

Vir Lakshman
KPMG in Germany
T: +49 211 475 6666
E: vlakshman@kpmg.com

Vikram Hosangady
KPMG in India
T: +91 98410 85580
E: vhosangady@kpmg.com

Ikuo Mori
KPMG in Japan
T: +81 3 5218 6735
E: ikuo.mori@jp.kpmg.com

Lex Gardien
KPMG in the Netherlands
T: +31 (0)10 453 4163
E: gardien.lex@kpmg.nl

Miguel Angel Castello Sanz
KPMG in Spain
T: +34 914 563 556
E: mcastello@kpmg.es

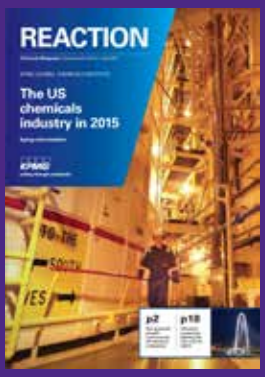
Erik Willems
KPMG in Switzerland
T: +41 58 249 6304
E: ewillems@kpmg.com

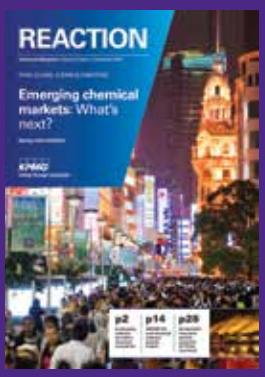
Frank Mattei
Global Tax Lead
T: +1 267 256 1910
E: fmattei@kpmg.com

Paul Harnick
Global COO and Head of Chemicals
KPMG in the UK
T: +44 20 7694 8532
E: paulharnick@kpmg.com

Nancy Barrett
Global Marketing
T: + 1 416 777 8197
E: nancybarrett@kpmg.ca

Missed an issue of REACTION?





Back issues are available to download from:
kpmg.com/reaction

kpmg.com/app

Download on the App Store

kpmg.com/socialmedia

kpmg.com/reaction

Designed by Evalueserve.
Publication name: REACTION Magazine – Eighteenth Edition
Publication number: 132916-G
Publication date: December 2015