CHEManager INTERNATIONAL

4/2014

THE NEWSPAPER FOR THE CHEMICAL AND LIFE SCIENCE MARKETS

The Million-Dollar Question

Can the plastics industry resume its success story despite looming challenges?

Page 6

Safer and Greener Fireworks

Measures to lessen air pollution and reduce hazards caused by pyrotechnics.

Page 14

Newsflow

Business:
Ineos Chairman Jim Ratcliffe said the European chemical industry could go down the drain.

More on **Page 2** ▶

Markets:
European chemicals sector output was stagnant in 2013, according to Cefic's new Chemicals Trends Report.

More on **Page 3** ▶

M&A News:
Solvay has acquired U.S.-based Plextronics, which filed for bankruptcy protection in January of this year.

More on **Page 5** ▶

Companies:
Dow Chemical has lifted its asset sale target from $3-4 billion to $4.5-6 billion.

More on **Page 7** ▶

Sales & Profits:
The global chemical industry presented mixed results for 2013 as many players have been or are still in transformation.

More on **Page 8** ▶

Materials Know-How

BASF Aims to Support Future Growth by Bundling Specialty Polymers in the Performance Materials Division

Tangible Synergies — In an organizational move in January of 2013, BASF created the new Performance Materials division. The new group, which is part of the Functional Materials & Solutions segment, includes BASF's engineering plastics, polyurethanes, thermosetting epoxy resins, functional foams, biopolymers, and styrene-based foam products. Reporting sales of €6.5 billion in 2013, the division is active in a huge number of industry sectors. Dr. Martin Brudermüller, Vice Chairman of the Board of Executive Directors of BASF, is responsible for the Performance Materials division. He is also in charge of the Region Asia Pacific headquartered in Hong Kong. Dr. Michael Reubold caught up with him on his growth plans and expansion strategy.

Asia will continue to dominate global growth.

Dr. Martin Brudermüller, Vice Chairman of the Board of Executive Directors, BASF

***CHEManager International:** Dr. Brudermüller, by bundling all specialty polymers in the newly created Performance Materials division, BASF aims to support future growth in the market with its downstream plastics. How will this organizational move help to achieve this goal?*

M. Brudermüller: Our Performance Materials division combines materials know-how and the innovative, customized plastics from BASF in one entity which is active in key industry sectors, such as transportation, construction, industrial applications and consumer goods. In keeping with differentiation on the basis of business model and customer requirements, units with a customer and industry sector focus are now separated more clearly from units that focus on chemistry and production.

With their variety of products and their understanding of application-oriented system solutions, BASF material experts can make a significant contribution here. Key drivers of profitability and growth are close collaboration with our customers, the portfolio shift towards solutions and specialties, a constant flow of innovative products and applications and large innovation and R&D capabilities.

With the creation of the Performance Materials division the Polyurethanes business moves into one organization with the other plastics activities. Will you look to leverage synergies between these formerly divided business groups?

M. Brudermüller: Take for example our insulation materials for the construction sector. EPS insulation foams like Neopor and Styrodur are now merged with numerous polyurethane insulation foams from the Elastopor, Elastopir and Elastospray product range. From this huge portfolio, BASF construction experts can recommend the best individual solution. For the automotive field, too, all materials are now under one roof. All relevant lightweight technologies are now also close to each other and will lead to tangible synergies for our customers. The next big step toward replacing metal is continuous-fiber reinforcement of injection-molded structures, based for example on thermoplastic composites. Composites offer an additional weight reduction of up to 60% per part compared to steel. If developing well, this market will have a size of roughly €2 billion in 2030.

BASF is strengthening its specialty polymer business with a number of investments. These include capacity expansions as well as acquisitions. What is currently going on in terms of strategic investments?

M. Brudermüller: Our goal is to continue to grow while remaining profitable, to serve the established markets even better, to participate in attractive growth markets and to develop new business activities. Key investments in specialty polymers include in Korea a new plant for Ultrason, which is widely applied in the electronics, automotive and aerospace industries for the production of heat-resistant, lightweight components. Also in Korea we are constructing a new compounding plant for engineering plastics Ultramid and Ultradur compounds. With our new integrated hub for polyurethane manufacturing in Dahej, India, we aim to ensure local supply for growing markets such as appliances, footwear, automotive and construction.

In terms of geographies, where will the bulk of these investments flow to in the future? Do you see the U.S. regaining attractiveness again due to the shale-gas boom?

M. Brudermüller: The shale gas revolution in the U.S. is attracting investments by chemical companies, because a significant proportion of chemicals are natural gas-based. This is a fundamental change for a significant time period and therefore relevant for long-term investments. The gas price will continue to be substantially lower than in Germany where the gas price is currently at least double. And the energy price difference is even 1:3. As one of the largest chemical companies operating in the U.S. BASF benefits from this significant cost advantage. At our Geismar site in Louisiana we are constructing a world scale plant for the production of formic acid. And we are considering to build a world-scale ammonia plant with Yara at the U.S. gulf coast. In the coming five years, we will invest additional €3 billion in the U.S.

As you just said, BASF is investing not only in its specialty business but also in basic products required for the specialty polymers business. What are the crucial advantages of this backward integration?

M. Brudermüller: In our Performance Materials business we benefit from our high operational and technological expertise in the production of commodities and basic products. Due to backward integration in our plastics production processes, we offer a high degree of security in terms of availability and quality of our specialties. Production at our Verbund sites is highly cost-effective. For that reason, we target investment in the basic products that are so important to our specialty business such as a new world-scale TDI plant in Ludwigshafen, which is due to start operations at the beginning of 2015.

The shale gas revolution in the U.S. is attracting investments by chemical companies.

You are responsible for the Asia Pacific region, the most vibrantly growing market in the world. What is BASF's strategy to participate in this growth?

M. Brudermüller: Asia will continue to dominate global growth. We expect that the contribution to world chemicals output in the emerging countries in Asia will have a share of 60% of global production within less than ten years. This means for us a need to build up production in Asia. Our goal is to locally produce approximately 75% of all BASF products we sell in Asia Pacific by 2020. Local production allows us to be closer to our customers, enabling us to address their requirements much more flexibly and improving our supply capabilities.

Together with our partners, we will invest €10 billion in Asia Pacific. This includes large-scale plants for more upstream products in China such as the new MDI plant in Chongqing, plants for acrylic acid, butyl acrylate and super absorbent polymer at our Verbund site in Nanjing, and a world-scale isononanol plant in Maoming.

In downstream products we are also planning to invest more than €360 million in Malaysia together with our partner Petronas to build an integrated aroma ingredients complex.

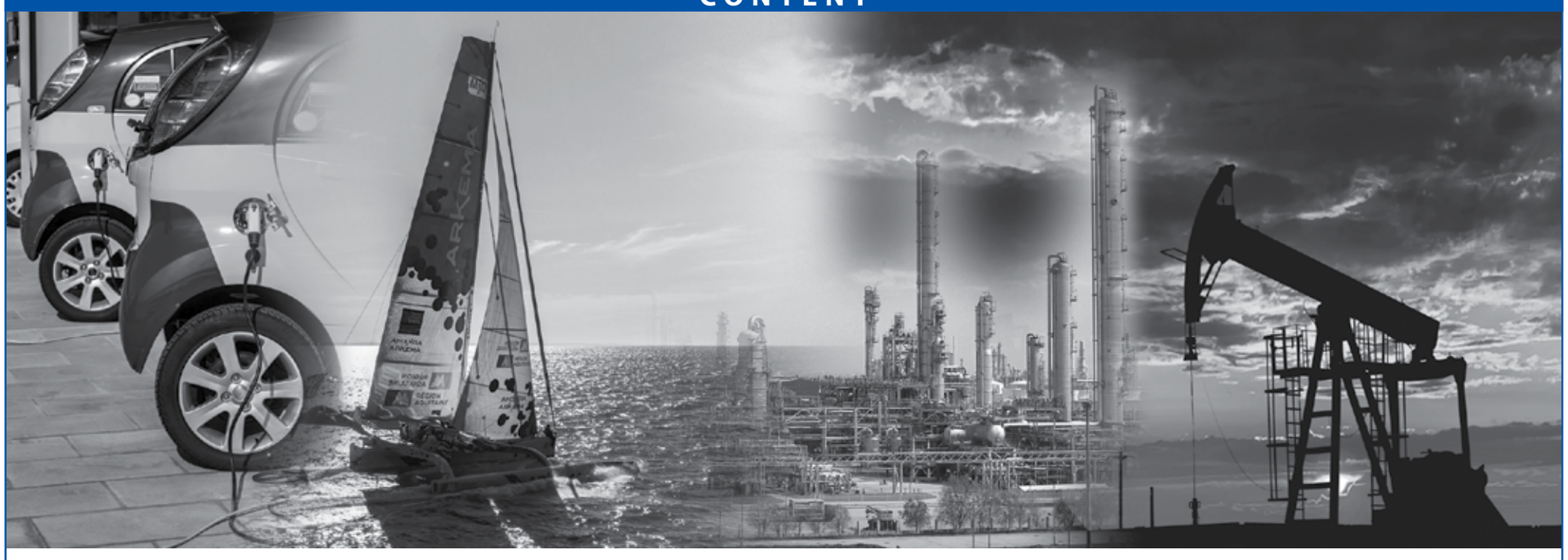
To serve our local customers with excellent research and development we recently opened our first Innovation Campus Asia Pacific in Shanghai. It is our largest R&D site outside of Germany.

BASF plans to locally produce approximately 75% of all products the company sells in Asia Pacific by 2020. To reach this goal, BASF and its partners will invest €10 billion in the region. The investments include plants for acrylic acid, butyl acrylate and super absorbent polymer at the Verbund site in Nanjing where the German chemical company also operates a steam cracker (photo).

Continues **Page 7** ▶

WILEY VCH · PF 11 05 64 · 69469 Weinheim · Pressepost · DPAG· Entgelt bezahlt · 78719

CONTENT



Russian Investment Group Wins Race for Germany's RWE DEA

LetterOne, a consortium of Russian investors based in Luxembourg, has received the nod to acquire oil and gas exploration company RWE DEA from German energy group RWE, subject to regulatory approval. The investors led by Russian billionaire Michail Fridman are said to be prepared to pay €5.1 billion for the Hamburg-based firm, including debt of €600 million.

With its offer, LetterOne edged out BASF subsidiary Wintershall, Hungarian oil and gas group Mol and a consortium of private equity group KKR with Kuwait-based Kufpec.

For the Russian-led group founded in 2013 this would be the first strategic engagement in the oil and gas sector. Fridman and another Russian billionaire, German Khan, established their L1 Energy fund in 2013 with capital sufficient to pump $20 billion (€14.4 billion) into oil and gas projects over the next three to five years.

RWE DEA has 1,400 employees worldwide, including 1,000 in Germany. RWE DEA, which reported an operating profit of €512 million in 2013, has shares in around 190 oil and gas licenses in Europe, the Middle East and North Africa. (dw) ■

Lanxess Sells Perlon Monofil Business to German Serafin Group

Troubled German specialty chemicals producer Lanxess has sold its wholly owned subsidiary Perlon-Monofil to Germany's Munich-based Serafin Group for an undisclosed sum. The divestment had been anticipated after the company last September said it was studying "strategic options" for certain non-core businesses.

Perlon-Monofil, one of the activities Lanxess inherited in its spin-off from Bayer in 2004, is a global market leader for polyamide and polyester (PET) monofil products sold under the trade names Perlon, Atlas and Bayco. The company with 100 employees and sales of €30 million operates a production facility and technical center at Dormagen, Germany.

Through its Nextrusion unit based near Augsburg, Germany, Serafin already has good standing within the PET monofilaments for paper machine clothing and other technical textiles, said Lanxess board member Werner Breuers. The acquisition will strengthen the market position both of Perlon-Monofil and Nextrusion, said Serafin managing director Philipp Haindl. (dw) ■

Ineos Chairman Ratcliffe Sees Industry Going Down the Drain

> *The chemical industry is a 'jewel in Europe's crown'.*
>
> Jim Ratcliffe, Chairman, Ineos

Another petrochemical heavyweight has taken the stage to warn that Europe's industry will lose competitiveness if it does not reduce its energy bill.

In an open letter to European Commission president Jose Manuel Barroso, Ineos chairman Jim Ratcliffe said the region's chemical industry could go down the drain within ten years, taking six million direct and indirect jobs with it.

In his view, a "toxic cocktail" of high energy costs, further burdened with "green" taxes, along with uncompetitive labor, are killing an industry with revenues of $1 trillion a year. Yet, he said, "Europe seems rather agnostic" about the industry's fate. The chemical industry is a "jewel in Europe's crown" that must be saved from extinction, he argued.

"Chemicals depend upon competitive energy and feedstock costs," Ratcliffe noted, adding that, "whilst intensely technical as an industry, and one of the reasons historically that Europe has been so successful, technology alone will not save it."

Making the pitch for exploitation of unconventional energy sources, the billionaire explained that gas prices in Europe are three times higher than in the U.S. and electricity costs 50% higher. "There are no cheap feedstocks in Europe."

In the U.S., where $71 billion worth of petrochemical expansions based on shale feedstock have been announced, and the numbers are "predicted to grow to over $100 billion," the new source of energy "has transformed both the country's competitiveness and its confidence," Ratcliffe continued.

In contrast, he said, "Europe announces closure after closure. In the UK, we have seen 22 chemical plant closures since 2009 and no new builds." (dw) ■

AMRI Acquires Cedarburg Pharmaceuticals

Albany Molecular Research Inc. (AMRI) announced that it has signed a definitive agreement to acquire all outstanding shares of Cedarburg Pharmaceuticals for $38.2 million in cash. The transaction, including $2.8 million of assumed liabilities, is valued at $41 million and expected to close in early April.

Cedarburg Pharmaceuticals is a contract developer and manufacturer of technically complex active pharmaceutical ingredients (APIs) for both generic and branded customers. Cedarburg is expected to continue to operate independently within AMRI's API business unit. Chuck Boland, currently co-founder and executive vice president of business development will lead the Cedarburg team and report into George Svokos, AMRI's senior vice president sales and general manager — API.

On a stand-alone basis, Cedarburg's forecasted full year 2014 revenue is approximately $19 million, with adjusted EBITDA between $5.5 million and $5.7 million, implying a purchase price multiple of approximately 2 times 2014 revenue and approximately 7 times 2014 adjusted EBITDA at the midpoint of the range. Adjusted EBITDA excludes any deal related costs or purchase accounting impacts. (dw) ■

Shell to Sell More Assets in "Fix or Divest" Strategy

Ben Van Beurden, the new CEO of Shell, has announced a "fix or divest" strategy to improve earnings. Plans include reduction of the budget for onshore gas extraction in the Americas as well as divestment of assets worth $15 billion, or 3% of the portfolio, by the end of 2015.

In the recent past, Shell has divested assets worth $4.5 billion, pulling out of at least two downstream projects in Australia and agreeing the sale of its retail and aviation businesses to Kuwait Petroleum.

In another pullback that will relieve environmental protection groups in the U.S., the group has shelved plans to drill off the coast of Alaska.

The moves come amid a poor performance of Shell's shale gas operations in North America. In particular, a sobering analysis of its wells in the Marcellus Basin in Pennsylvania revealed that the "vast majority" of its 630 wells performed less profitably than those of rivals.

"From 2014, tight-gas and liquids-rich shale will have a different role in our strategy," Van Beurden said, while stressing that this is a longer-term perspective. At the same time, he said the group is "reducing the number of these opportunities in our North American portfolio as we strive to improve our financial performance." (dw) ■

Codexis Sells Hungarian Operations

Codexis sold its Hungarian subsidiary to Intrexon Corporation. The transaction closed on March 13, with a purchase price of US$ 1.5 million. No proprietary Codexis materials or intellectual property were included in the transaction. "We are very pleased with this transaction," said John Nicols, President and CEO of Codexis. (dw) ■

Stagnation of EU Chemicals Output in 2013

Year Ends With Overall Strong December, Despite Petrochemicals Contraction

European Business — European chemicals sector output was stagnant in 2013, according to the Cefic's new Chemicals Trends Report. Zero growth in 2013 meant the sector remained 6.4% below the pre-crisis, full-year peak level reached in 2007.

The year-end figure was slightly better than the Cefic forecast given last September, which predicted a slight contraction of 0.5% for the year. Latest monthly data show output expanded 2.0% in December year on year, the fourth consecutive month of above-zero growth. A stronger second half 2013 helped pull the sector out of a recession.

EU chemicals exports keep driving sector activity, the net trade surplus reaching €45.8 billion through November 2013. The surplus grew by €779 million during the January-November 2013 period compared with the same period the year prior. EU chemicals prices fell 2.7% in December 2013 compared to December 2012. Year-on-year total sales were 3.3% lower for the first 11 months of 2013.

Sector confidence decreased slightly in January 2014, after increasing for three consecutive months. Capacity utilization saw a minor drop from 79.1% in the third quarter of 2013 to 78.8% in the fourth.

Sectorial Production Breakdown

Petrochemicals output continued to contract in December, down by 7.1% compared with December 2012. The steep drop was partially offset by strong growth in basic inorganics, up 8.8% in December year-on-year.

Polymers output expanded by 4.0% while consumer chemicals grew by 0.8%. Specialty chemicals expanded by 1.6% during the same period.

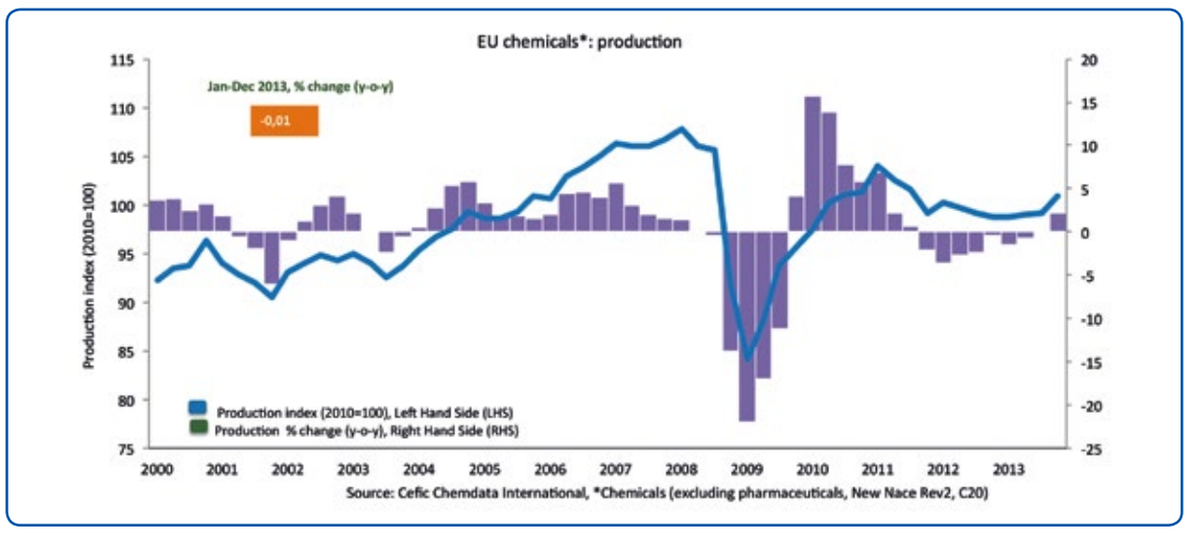
Chemical Price Development

EU chemical producer prices in December fell 2.7% compared to the same month the year prior. Producer prices for the whole year of 2013 were 1.0% lower than the year 2012. January-December producer prices remained 11.6% higher than the pre-crisis, full-year peak level reached in 2008.

Sales Remain Slightly above Pre-crisis Levels

EU chemicals sales in November dropped 2.0% compared with the same month the previous year. Sales for the first eleven months of 2013 were 3.3% less than during the same period in 2012. EU chemicals sales during the first eleven months of 2013 were 1.1% higher than the full-year peak level reached in 2008 before the crisis.

The EU chemicals net trade surplus continued to grow, reaching yet another record level. The surplus stood at €45.8 billion during the first 11 months of the year. The surplus was led by a €14.4 billion positive trade balance with non-EU countries in Europe, including Russia — up €0.5 billion from the same period in 2012. The Jan.-Nov. 2013 trade surplus with Asia — excluding Japan and China — reached €6.7 billion, up €2.2 billion on the same period the year prior. The EU net chemicals trade surplus with China decreased slightly from €1.33 billion in Jan.-Nov. 2012 to €1.27 billion during the comparable period in 2013. The U.S. continued to close the trade deficit gap with the EU, narrowing during the 11-month period by €2.1 billion to €6.0 billion.



Confidence Fell Slightly in January

The EU chemical industry confidence indicator (CCI), generated by Cefic, was lower in January 2014 compared with December 2013. Companies' output expectations for the months ahead had an impact on the lower reading. Overall order books for the coming months registered also a downturn in January 2014 compared to December 2013. The confidence reading for the sector in January was above the long-term average, measured from 2005 to 2012, for the fifth consecutive month. Capacity utilisation in the EU chemical industry decreased slightly, from 79.1% in the third quarter of 2013 to 78.8% in the fourth. But it remains 6.6% below the post-crisis peak level recorded in the second quarter of 2011.

Dr. Moncef Hadhri,
Chief Economist, Cefic
Brussels, Belgium

▶ www.cefic.org

Ineos and Solvay Offer More Divestments for PVC Merger Approval

In another attempt — just under the wire — to win EU approval for their proposed 50:50 PVC joint venture, Ineos and Solvay have wrapped up another package of proposals for divesting assets.

Announcing its in-depth probe into the JV plans in November 2013, the European Commission said it was concerned about a loss of competition in the EU market for suspension PVC (S-PVC) as well as for the bleaching agent sodium hypochlorite, in particular in Belgium. For both products the Brussels authority said the new company would be a heavyweight player.

Having pieced together assets sold by older, established players during more than a decade, Ineos is already Europe's largest producer of S-PVC, which accounts for 53% of its chlorine-related assets. Initially, the potential partners had offered to divest Ineos' 320,000 t/y PVC plant at Schkopau, Germany — acquired from Dow Chemical — and its 370,000 t/y plant at Wilhelmshaven, Germany — formerly belonging to European Vinyls Corporation, a joint venture of Enichem and ICI — as well as 400,000 t/y of vinyl chloride (VCM) capacity. However, the Commission said "the commitments failed to provide a sufficiently clear-cut solution."

The latest proposal presented by Solvay and Ineos calls for the additional divestment of PVC plants at Beek, The Netherlands (Ineos) and Mazingarbe, France (Solvay), along with the shedding of assets in chlor-alkali, ethylene dichloride (EDC) and vinyl chloride monomer (VCM) in Tessenderlo, Belgium, acquired by Ineos from the company of the same name in 2011.

Ineos' PVC plant at Schkopau is downstream of a 330,000 t/y VCM plant operated by Dow at the site of a former East German chemical combine it spectacularly acquired from the German government and built up in the 1990s. (dw) ■

Hanwha Chemical a Possible Buyer for Dow Chlor-Alkali Business

No potential buyers have yet come forward announcing plans to buy the chlor-alkali business Dow Chemical has said it plans to sell. However, South Korea's Hanwha Chemical said it has engaged Credit Suisse to advise it on possible purchases. A spokesman for Hanwha told the news agency Reuters its interest is "in the early stages."

As part of plans to "right size" its chlorine footprint to meet its needs in downstream markets, Dow in December 2013 said it would carve out "a significant portion" of its chlorine value chain over the next two years. (dw)

■

Sotragem Offers to Buy Mothballed LyondellBasell Refinery

Monaco-based oil products trading company said it has offered to buy Sotragem LyondellBasell's mothballed Berre refinery in southeastern France.

Sotragem declined to say how much the offer was worth, but French industry minister Arnaud Montebourg said the company had presented plans to invest €400 million in the facility over three years. This, he said, could lead to the creation of more than 200 jobs.

LyondellBasell mothballed the refinery in January 2012, having failed to find a buyer since putting it up for sale in May 2011.

If the deal goes through, it would run against the recent trend of European refinery closures in the face of vast overcapacity. (dw)

■

Water – Fuel for Processes and Products

The Close Interlinkage of "Water and Energy" was Under the Spotlight on World Water Day 2014

Sustainable Management of Resources — Water is the origin of all life and is extremely important to each and every one of us. That is why, in 1993, the United Nations introduced an annual World Water Day that is held annually on 22 March as a means of focusing attention on the importance of freshwater and advocating for the sustainable management of freshwater resources.

Jean-Marc Vesselle
Lanxess

The focus changes each year and in 2014 "Water and Energy" was under the spotlight. This raises another issue that, despite its importance, is rarely a subject of public discussion – the link between clean water and the global rise in energy demands. The chemical industry makes a major contribution to both these issues.

Industrial Use of Water

Discussions relating to water and energy are often restricted to the generation of electricity at hydroelectric power stations. Naturally, huge quantities of water are required to keep the large turbine wheels turning but the quality and purity of the water used play only a minor role. Water from hydroelectric power stations can be used for other purposes without first having to be cleaned.

Other industries have far higher demands on water as a raw material though, whether used to generate electricity from fossil fuels or nuclear energy, in the chemical industry, for paper making or in the electronics sector. Even in mining, food processing, steel manufacturing and automotive engineering, virtually nothing is possible without water. For example, it takes 500 l of water to produce one kilogram of paper, some 10,000 to 20,000 l to build a car and as much as six metric tons of water to manufacture one metric ton of steel.

Worldwide, over 20% of all the water extracted from surface sources such as rivers, lakes and from groundwater is used for industrial purposes. In highly developed regions such as Europe, this figure is as high as 60%, whereas in developing countries it is just under 8%. In Germany, industrial usage accounts for as much as 84% of extracted water. Thermal power stations use some three-quarters of this – primarily for cooling purposes. Around 630 l of cooling water is required per day and per person simply to cover Germany's electricity requirements but most of this is recycled in closed circuits.

Ion exchange resins for industrial water treatment from the Lewatit range play an important role in industrial water treatment, food processing and many processes of the chemical industry.

Over half the water used in the manufacturing industry – not counting cooling water for power stations – is required by the chemicals sector. This amounts to approximately 30% of the entire volume of water extracted in Germany. Other relatively large consumers of water include the mining industry, the manufacturing and processing of metal, the food industry, paper making and the printing sector.

Water Treatment for Safe Energy Generation

Complex chemical and mechanical treatment processes are needed for cooling water, process water and almost pure, completely desalinated water at power stations.

In most cases, ion exchange resins are used to soften and desalinate the feed water. This is essential because the high temperatures at the power station would otherwise cause the salts and alkaline minerals that are present in water to build up on the heating surfaces as boiler scale and form an insulating layer that would prevent heat transfer. This can lead to thermal stress cracks or even cause the boiler to burst and give rise to corrosion, abrasion and imbalance among components on the steam side, for example in the turbine.

A second, downstream step is sometimes required, for instance if the water contains a high proportion of organic substances. These, too, can damage the turbine and other components in the water-steam cycle. This second, downstream step is called reverse osmosis.

At the Chemnitz combined heat and power station, for instance, these membrane filter elements from Lanxess significantly lower the degree of fluctuation in water quality and, in particular, filter out organic substances. In addition to this, reverse osmosis can be used, for example, to desalinate brackish water or seawater to produce drinking water.

Ion exchange and reverse osmosis are complementary technologies and are therefore often combined to an optimal effect. Lanxess' LewaPlus software for the planning and design of complex water treatment plants combines the two technologies in a single planning tool so as to offer customers significant added value.

Conserving Resources through Multiple Usage

Thanks to numerous changes in production processes and ongoing optimization of water treatment, it has been possible to steadily reduce the consumption of water by using it several times. Here, too, products from the chemical industry have played a key role.

The number of times water is used in the paper industry has risen from 2.4 in the 1950s to about 12 at present. In the chemical industry, water is now recycled an average of 28 times before it is channeled downstream through the sewage clarification system and then allowed to re-enter the water cycle having been purified.

Further progress is still to come though, since the chemical industry serves as a link – in both senses of the word – between water as a raw material and energy generation. Germany's fourth-largest industry not only offers innovative approaches for the efficient use of water as a raw material but also provides solutions for resource-saving, sustainable energy generation. To mark this year's World Water Day, let's acknowledge the chemical industry's contribution to things we tend to take for granted – such as clean water and a reliable supply of energy – because this role will become even more important in the future.

Jean-Marc Vesselle, Head, Liquid Purification Technologies (LPT), Lanxess, Leverkusen, Germany
www.lanxess.com

Lewabrane membrane elements at a thermal power plant's reverse osmosis facility in Chemnitz, Germany. © Eins Energie in Sachsen

Global M&A to Increase in 2014

New A.T. Kearney Survey Analyzes Chemical Industry

Focus on Specialty chemicals

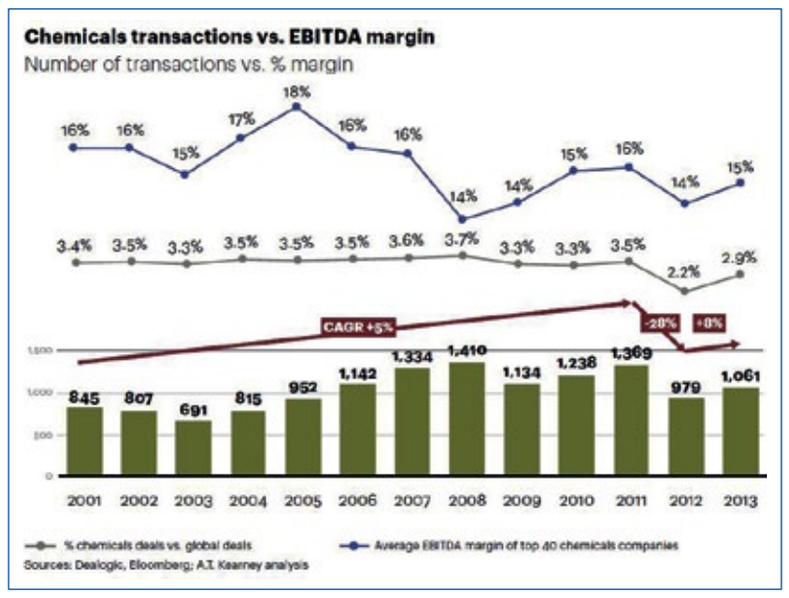
— Despite lingering uncertainty about Europe's recovery and global GDP growth, more than 50% of executives surveyed at leading chemicals industry players and investment banks expect M&A activity to increase globally in 2014.

The survey, conducted as part of A.T. Kearney's second annual "Chemicals Executive M&A Report" shows growth in chemicals M&A activity will be driven by the high liquidity of chemicals companies, resurgence of the U.S. chemicals industry because of low-cost feedstock, regional expansion plans of Asian companies pursuing growth through acquisitions in Western economies, and Western companies seeking access to developing markets. The report includes an analysis of global chemicals sector M&A deals in 2013 and a forward view of expected 2014 sector M&A activity.

"Consolidations are expected to account for the largest share of all transactions, due to the still highly fragmented Asian markets and to Western chemical companies focusing their M&A activities on strengthening their core businesses, " said Joachim von Hoyningen-Huene, A.T. Kearney partner and author of the study.

2013 M&A Analysis

The analysis shows that 2013 M&A deal activity recovered slightly compared to low levels in 2012. Deal activity was driven by strategic investors' strong balance sheets, significant funds available to private equity, and the low cost of debt.
The value of deals in 2013 increased sharply by 47%, mainly due to a rise in large transactions with private equity participation. Private equity company share of chemicals transactions stayed at almost 20% from a volume standpoint, but value rose from 22% to 32% in 2013.
Companies in the specialties and fine chemicals sector are the most sought-after acquisition targets. Between 2001 and 2013 the share in deal volume remained relatively constant across all chemicals industry sectors. In terms of value, the share of specialty and fine chemicals deals rose by more than $7 billion since 2001, equaling a CAGR of almost 8%.



Thomas Rings, A.T. Kearney partner and study author noted, "This trend reflects the increasing focus of Western and Asian companies on specialty chemicals. They are on the one hand attracted by higher margins and lower cyclicality and on the other want to create scale in the different specialty segments. Competition is rising for buying specialty chemicals assets, which translates into higher valuations."
Asian, specifically Chinese, acquirers are becoming more active, both in their domestic markets, driven by further consolidation of the chemicals industry, and outbound, seeking access to specialty chemicals know-how as well as increasing their global dominance in certain commodity chemicals by buying foreign targets at attractive valuations.

2014 M&A Outlook

The new survey results suggest that M&A activity in Asia, particularly in China, will increase as buyer interest in China remains high and the number of businesses available for acquisition has gone up. M&A activity is expected to also rise in North America, driven by the objective to gain access to low-cost feedstock and by portfolio realignments of large chemicals players that will bring sizable assets to the market. With regard to sectors, survey results indicate that deals will continue to focus on specialty and fine chemicals with higher deal levels than 2013. The M&A activities in petro and basic chemicals will remain stable with a slight upward trend.

Key findings

- Chemicals M&A volume increased at an annual rate of 5 percent in the period 2001–2011
- In2013, global chemicals M&A deals showed an 8 percent increase in volume over the prior year's low but did not recover from 28 percent dip in 2012
- Deal volume peaked in 2008, at a level 30 percent higher than in 2013
- Especially fom 2009 onward, deal activity is largely in sync with the industry's average profitability
- Buyers and sellers seem to align ther M&A activities my better to the profitability expectations of the industry than in the period 2005–2008

For the full report visit www.atkearney.com

▶ Contact
Meike Fuhlrott
A.T. Kearney GmbH
Düsseldorf, Germany
Tel.: +49 211 1377 2275
meike.fuhlrott@atkearney.com
www.atkearney.com

Solvay Acquires Bankrupt Plextronics for $32.6 Million

Toward its goal of expanding further into printed electronics markets, Solvay has acquired U.S.-based Plextronics. The purchase price was not disclosed, but the Belgian chemical company earlier was said to have offered $32.6 million for all shares of the Pittsburgh, Pennsylvania-headquartered company, which filed for bankruptcy protection in January of this year. Solvay held 47% in Plextronics, after taking an initial stake in 2007 as part of an effort to bolster its electronics franchise. In 2010, it acquired a minority stake in another printed electronics firm.

The U.S. company's technology uses stacked layers of organic compounds that emit light when submitted to an electric current and is said to boost luminance efficiency and ultimately enables bendable displays as it reduces their thickness and weight.

Along with bolstering its know-how for light-emitting diodes (OLEDs), the latest buy will enable Solvay to create a development platform in Asia. Solvay is also establishing a new electronics laboratory at its research center at Ewha Woman's University in Seoul City, South Korea. (dw) ■

CF Industries Completes Sale of Phosphates to Mosaic

U.S. fertilizer maker CF Industries has completed the sale of its phosphate business to compatriot The Mosaic Company of Plymouth, Minnesota, for $1.4 billion. The deal originally announced in October 2013 includes a phosphate mine and beneficiation plant, a phosphate manufacturing facility and an ammonia terminal and finished product warehouse facilities near Tampa, Florida.

Headquartered at Deerfield, Illinois, CF Industries claims global leadership in nitrogen fertilizer, and Mosaic bills itself as world's largest combined producer of potash and phosphates.

Adding CF's 1.8 million t annual output of phosphate fertilizer to its own, Mosaic's phosphates capacity will rise to more than 11 million t. As part of the takeover arrangement, CF Industries will supply Mosaic with its share of the ammonia produced by the company's 50% owned production facility in the Republic of Trinidad and Tobago.

It also has a long-term supply agreement with Mosaic to supply between 600-800,000 tons of ammonia per year for up to 15 years from its Donaldsonville, Louisiana, nitrogen complex. (dw) ■

The Million-Dollar Question

Can the European Plastics Industry Resume its Success Story Despite Looming International Challenges?

Recovering from the Economic Crisis — The European plastics industry will have to overcome some major challenges in the near future and work hard to maintain its leadership. Looking back, the industry had steadily grown over the years leading up to the 2008–2009 economic crisis, which put the brakes on this growth.

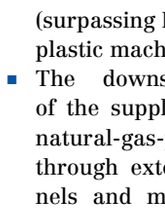
"We saw strong growth for the production of primary plastics and plastics products during the 1990s, followed by a more sideways development from 2000 to 2005," said Patrick Thomas, president of PlasticsEurope and CEO of Bayer MaterialScience.

"The dramatic impact of the economic crisis was clearly recognizable in 2008 and 2009 as the European plastics production fell by around 15% compared to 2007. The economic crisis thus had a tremendous impact on demand of our customer industries. I think it is fair to say that the drop of volume in 2009 changed since then the dynamics of our industry," Thomas said.

However, the industry has adapted to that very difficult economic climate, showing enormous resilience. "These two factors, the adaptability and resilience of our industry, are the most important ones, leading me to think that the plastics industry has what it takes to overcome these difficult years and to resume its growth pattern in future," Thomas said.

Speaking at the K Show last October in Dusseldorf, Germany, Thomas remarked that the economic recovery in the plastics industry — including plastics producers, plastics converters and the plastics machinery sector — lasted from mid-2009 until 2011, but that, in terms of turnover, the plastics industry has not yet reached pre-crisis levels. In October, the evolution of the different sectors of the European plastics industry during the first half of 2013 and the expectations for the second half of the year indicated that 2013 was a year of stabilization for the plastics industry.

For 2014, the industry expects a slight recovery of the plastics production, although it will continue to remain far from pre-crisis levels. According to the president of PlasticsEurope, "This indicates a cautiously positive climate which, in conjunction with measures that we expect policymakers will put in place to secure the reindustrialization of Europe, will help our industry to cope with external challenges that we will have to face in the years to come."



Plastics will continue to push the boundaries of human genius and innovation.

Patrick Thomas, president of PlasticsEurope and CEO of Bayer MaterialScience

Challenges for the European Plastics Industry

In a recent study carried out by The European House — Ambrosetti, the Italian consulting group, the highly competitive international context is undergoing a change. There are several potentially disruptive factors (or "game changers," compare Figure 1) that will certainly affect the plastics industry, namely:

- The competitive advantage of the U.S. in terms of energy after the discovery of shale gas and shale oil deposits;
- The growth of China on the global scene of plastics production (surpassing Europe in 2010) and plastic machinery;
- The downstream integration of the supply chain in oil- and natural-gas-producing countries through external growth channels and massive downstream investment (processing);
- The potential role of Brazil and other Latin American countries in the production of biofuels and bio-based plastics.

"The reduction of energy costs in the U.S. has obviously changed the competitive environment," Thomas said. "The introduction of 'non-conventional' into the energy mix in the U.S. — shale gas currently accounts for 10% of the U.S. energy production and will rise to 36% by the year 2035 — should not come as a surprise to Europe. This is an industry which has existed for more than 40 years."

In terms of global plastics production, China surpassed Europe in 2010. In 2012, China, for the third year in a row, remained the leader with a share of 23.9% of global plastics production. The gap between China and the rest of the Asian countries is increasing year by year.

The development in plastics processing in India, thanks to the development of manufacturing sectors such as the automotive industry, has also brought a big shift to the balance of the industry in this part of the world.

The Middle East has become a major force on the global stage with direct access to fossil resources, as 67% of the world's oil reserves and 45% of the world's natural gas reside in the region, giving it the unique opportunity to export materials based on natural gas at very low costs.

And finally, the new role of Brazil and other Latin American countries, which have large production of biofuels and bio-based plastics, is having a dramatic effect on the mix of polymers.

"However, this is not a picture of gloom and doom, but rather of reality," Thomas said. "This is the current state of dynamics in the plastics industry. Every challenge is an opportunity, and we do believe that with the right measures in place, supported by European policymakers, our industry will play a key role in Europe's reindustrialization."

Key Player for the Reindustrialization of Europe

In the framework of the EU Industrial Policy Flagship Initiative, the European Union has set the goal of reaching a 20% share of gross domestic product for industrial activities by 2020. PlasticsEurope, the trade association representing the European polymer producers, believes this goal to be realistic, as long as the plastics industry plays a major part.

According to the Ambrosetti study, this industry is one of the sectors providing the greatest contribution to manufacturing with a multiplier effect of 2.4 (as calculated for Italy). Assuming the same multiplier applies to Europe, an increase of €15 billion in the plastics industry turnover could result in a €36 billion increase in the EU GDP.

The same study examines R&D activities, ranking the plastics industry among the top 10 most innovative sectors in Europe with more than 63,000 patents submitted in the last 10 years. The plastics industry is a driver for innovation, directly influencing many other industries.

Contemplating the future growth opportunities for his industry, Patrick Thomas sums it up this way: "Is this success story to go on? That is the million-, dare I say billion-dollar question! I believe the answer is: Yes!"

Material of Innovation and Creativity

The plastics industry is a key contributor to the European economy, delivering the needed innovation to drive substantial and sustainable European industrial growth. To achieve this, Europe must put in place appropriate measures and strong industrial policies, to guarantee this industry's competitiveness, allowing it to effectively contribute to the relaunch of the European manufacturing sector. Thomas is optimistic: "Finally, our industry is a resilient one that has always faced challenges and adapted to changing circumstances. Plastic is the material of innovation and creativity. It has inspired architects, designers, engineers and inventors in every sector, and I firmly believe that it will continue to push the boundaries of human genius and innovation."

Dr. Michael Reubold, CHEManager International

Info

The European plastics industry makes a significant contribution to the welfare of Europe by enabling innovation, creating quality of life for citizens and facilitating resource efficiency and climate protection. PlasticsEurope represents European polymer producers. The trade association, with headquarters in Brussels, has more than 100 member companies, producing over 90% of all polymers across the EU 28 member states as well as Norway, Switzerland and Turkey. In total, the European plastics industry — including polymer producers, converters and machine manufacturers — employs more than 1.45 million people to create a turnover in excess of €300 billion per year.

▶ www.plasticseurope.org

Materials Know-How

Continued **Page 1**

GDP growth in Asian countries has been losing dynamic recently. Did you have to adjust your long-term strategy to this situation or do you believe it is only a rest period before picking up pace again?

M. Brudermüller: Our strategy is for the long term. In particular, BASF believes local innovation and production are important drivers to business growth, and this is reflected in our strategy — innovations from Asia, for Asia, but increasingly also for the world. BASF develops new applications, products

and solutions together with our customers in Asia, adapted for Asian needs. Based on our strong global R&D network, we will considerably strengthen our innovation capabilities in Asia Pacific, enabling us to better serve our customers in this region. In particular, this includes electronic materials, agriculture, catalysis, mining, water treatment, polymers and minerals.

BASF will invest in a range of efficiency measures that will save approximately €1 billion annually by 2020. Excellence in functional units, marketing and sales, organization structures, investment processes and operations are the focus areas addressed to establish a competitive advantage for BASF in the region.

BASF's spending on research and development hit another record high of €1.8 billion in 2013. What can we expect to come out of your R&D group in the short and middle term?

M. Brudermüller: We have bundled our polymer and additives research in one technology platform and developed it further into the division Advanced Materials & Systems Research. Advanced materials form the basis for developing multi-material systems such as those we are developing for the growing wind energy market and other areas. We have now established interdisciplinary research groups which specialize in working on lightweight composites from reactive resins and carbon fibers or, to give another example, novel membrane materials with nanopores to filter drinking water.

The holistic systems-based approach in R&D will involve developing tailored solutions in close

> ***In the coming five years, we will invest additional €3 billion in the U.S.***

collaboration with our customers. Cooperation with research institutions and universities is another very important element. Recently, we inaugurated the research initiative "North American Center for Research on Advanced Materials." We succeeded in bringing together researchers from Harvard University, the Massachusetts Institute of Technology and the University of Massachusetts Amherst in this initiative. Research activities include microstructures and nanostructured polymers with new properties. The next step will be to investigate lightweight materials for wind turbines and automobiles, and engineering materials for the construction and energy industries.

The increasing use of biopolymers presents another growth market. BASF plans to expand its business in this area. How do you want to do this?

M. Brudermüller: Resource conservation and climate protection are important drivers of the increased use of renewable resources. We are currently stepping up research into a biodegradable and primarily biobased foam with properties similar to those of EPS for use as packaging for food and electric and electronic goods, an area that is seeing a surge in demand for biobased and biodegradable solutions. However, both supplier and converter have to accept that a product property like 'biobased' incurs additional costs due to the different raw material base and the rather new biorefinery technology.

An innovative product with diverse applications is Ecovio, which contains a high proportion of polylactic acid derived from corn starch. Despite a high renewable raw material content of about 50%, Ecovio is sufficiently stable for numerous applications, including the manufacture of tear-resistant bags, mulch films, coated paper, dishes and cups or coffee capsules.

To respond more effectively in future to customer interest in biobased materials, BASF has developed an innovative mass balance approach. Can you explain what led you to the development of this approach and what results you expect from it?

M. Brudermüller: We want to respond more effectively to our customers' increasing interest in materials based on renewable feedstocks. In cooperation with TÜV Süd we have developed an innovative mass balance approach for the use of renewable feedstocks in the integrated production. The process is available immediately for many products and can be adapted to customers' requirements. Based on this approach, biomass is used as a feedstock in the manufacturing of basic products in existing plants. This biomass share is then allocated to sales products according to their recipes using the new certified methodology. The quality of the products remains unchanged.

The products mass balanced in this manner save fossil raw materials and reduce greenhouse gas emissions, thereby contributing to

> ***Local innovation and production are important drivers to business growth.***

sustainable development. Existing plants and technologies along the value chain can continue to be used, and the customers' product formulations do not have to be adjusted.

Thus, bio-naphtha and biogas, for example derived from organic waste, are used for the mass balance approach. Our Dispersions & Pigments division has supplied a large adhesives customer with initial amounts of mass-balanced products, dispersions for construction adhesives. TÜV Süd has meanwhile issued certificates for 14 products. These include superabsorbents for diapers, performance polymers for electronic goods and further intermediates. ■

Sinopec to Cut Spending After Earnings Drop

After reporting a 35% earnings decline for the 2013 fourth quarter, Chinese oil and petrochemicals giant Sinopec said it would cut capital spending to just under $26.2 billion in this year, down from $27.4 billion last year.

The state-owned group recently unveiled a plan to sell up to 30% of its marketing and distribution business, which analysts believe could raise $10-$20 billion. The business, which includes convenience stores, petrol stations, as well as oil-products pipelines and storage facilities, saw an 18% profit drop in 2013.

Observers said Sinopec's strategy to improve efficiency and thus profitability mirrors the current trend in the global oil industry and echoes plans by rival Chinese energy firm PetroChina - which said it would cut capital spending for the second consecutive year.

China's refiners are still unable to fully pass on higher crude costs to consumers because the government controls oil prices to help to curb inflation. Sinopec's refining division returned to profit in 2013 after a loss in 2012, although this was negatively offset by a decline in operating income from exploration and production arm partly, which partly reflected lower international oil prices.

Operating profit in the chemicals division fell 26% due to an increase in domestic production capacity and lower selling prices. ■

Dow Lifts Asset Sale Target to $4.5-6 Billion by End of 2015

Dow Chemical has lifted its asset sale target from $3-4 billion to $4.5-6 billion. The company already has announced it would sell its epoxy business and some chlorine and derivatives assets. Dow did not specify where it plans to make the additional portfolio cuts up to 2015, although it hinted that the slow-growing electronic and functional materials and performance materials units were likely targets.

CEO Andrew Liveris said there are markets where Dow has small business with good EBITDA but "where we cannot grow." In October 2013, CEO Andrew Liveris upped the proposed divestment sum from the $1.5-2 billion announced earlier, but Dow's management meanwhile comes under increasing pressure from hedge fund titan Daniel Loeb to spin off its lucrative but slow-growing petrochemical unit and focus on specialty materials.

Liveris, however, is reluctant to split the business as it produces commodities such as ethylene and propylene as ingredients for higher value-added products and also has cash cows to fund high-growth specialty chemicals businesses. ■

Global Chemical Industry Presents Mixed Results

Many Players in Transformation, U.S. Firms Stalked By Activist Shareholders

Chemical Business — Annual results presented by global chemical companies for 2013 showed a diverse picture. This was scant surprise as many were still mired in a transformation process, while others with restructuring behind them were beginning to reap benefits.

Large German multinational players BASF and Bayer were firmly focused on the future and medium-sized producers Arkema, Solvay, Lonza and DSM moving swiftly in that direction. Evonik had already cleared a path, but Lanxess had painful moves ahead of it. In the U.S., activist shareholders were rattling corporate cages.

Across the international spectrum, corporate chieftains were cautious in their forecasts for 2014. Based on experience of past, all understand that whether forecasts are confirmed or fail to meet the target often depends as much on unforeseen events as on management's own efforts.


© Serg Nvns - Fotolia.com

Mood at German Chemical Companies Most Solidly Upbeat

Compared with European rivals, the mood at Germany's largest chemical companies was the most solidly upbeat. With the domestic economy relatively robust, business developed well. Faced with flat interest rates, the country's usually frugal citizens had put aside their piggy banks and consume. The export engine continued to run at full throttle, whether the rest of Europe liked it or not.

Although **BASF** chief Kurt Bock said economic headwinds buffeted business in 2013, the world's largest chemical producer outperformed management's cautious forecast. Despite a recent diversification drive, results were driven by bulk businesses such as oil & gas or petrochemicals. At the same time, the burgeoning shale gas bonanza rejuvenated the group's fairly stagnant North American activities.

The Ludwigshafen group closed 2013 with revenue of €74 billion, including oil and gas taxes, 2.6% ahead of 2012. EBIT before special items improved by 8% to €7.2 billion. In 2014, Bock expects sales and earnings to rise again, with "significantly higher" contributions from the Performance Products segment, which includes dispersions & pigments, care chemicals, nutrition & health, along with processing aids.

At **Bayer**, Germany's other large chemical multinational, business also held up well last year. Of the three corporate sub-groups, only MaterialScience lagged – a stress factor attributed to the overcapacity-plagued market for the engineering plastic polycarbonate. The HealthCare segment led the overall performance. Bayer's other life science segment, CropScience, also achieved its operational targets, group CEO Marijn Dekkers said.

Across all businesses, the Leverkusen group saw sales rise 1% in absolute terms to a record €40.2 billion. Adjusted figures show a 5% increase. EBIT before special items added 2.4% to reach €5.8 billion, and EBITDA rose 1.5% to €8.4 billion. In 2014, Dekkers expects currency- and portfolio-adjusted sales 5% higher at €41-42 billion, with EBITDA before special items improving by a mid-single-digit percentage figure. In problem zone polycarbonate, MaterialScience, CEO Patrick Thomas predicted that the market could begin turning around as two Asian players are cutting capacity and the liquid crystal display market appears to be reviving.

Slightly lighter German heavyweight, Essen-based **Evonik**, saw 2013 sales deteriorate by 4% to €12.9 billion. In absolute figures, EBITDA sank 18.6% to €2 billion, but CEO Klaus Engel said the performance was in line with expectations. With demand for most of its products healthy, volume growth accelerated quarter-by-quarter. Especially strong volume expansion was seen for personal and baby care products, feed amino acids, silica, coating applications and MMA.

For 2014, Engel predicted slightly higher sales, with adjusted EBITDA of €1.8-2.1 billion roughly in the same corridor as 2013. Volume trends are expected to continue positive. This year, Evonik hopes to begin reaping the benefits of its Administration Excellence scheme targeted to save up to €250 million annually. Over 450 levers for efficiency gains have been identified, the CEO said.

Lanxess, now headquartered at Cologne, Germany, was a true rags-to riches story for some time after its 2004 spin-off from Bayer, but the bubble burst in 2013. Declining selling prices and stiff competition for synthetic rubber left the company with a net loss and CEO Axel Heitmann without a job from the end of February 2014. Last year's figures show EBITDA pre-exceptionals plummeting 40% to €735 million on sales down 9% year-on-year to €8.3 billion. Writedowns had to be taken on several businesses.

The Performance Polymers segment took one of the worst hits, as higher raw materials prices for rubber production could not be compensated by higher selling prices. In a preliminary forecast for 2014, Lanxess said it expected improvement, not least because of the absence of one-time items. Former CFO Matthias Zachert, who returned to the company on Apr. 1 to take Heitmann's job is to provide more guidance at a press briefing on May 8.

Companies Struggle with Unfavorable Currency Effects

Swiss companies in particular faced headwinds from foreign exchange rates last year. At specialty chemicals producer **Clariant**, sales were flat at 6 billion Swiss francs, but rose 4% in local currencies. EBITDA before exceptional items improved by 5% (or 9% in local currencies) to 858 million Swiss francs. CEO Hariolf Kottmann said the company's "unfolding operational strength" became visible in a challenging economic environment. After divesting several businesses, it is "now a more profitable, less cyclical and well-balanced specialty chemicals player."

The Clariant chief expects 2014 to be a year of organic growth as the company moves closer to its mid-term target of taking a position in the top-tier of the specialty chemicals sector. An annual EBITDA margin pre-exceptionals of 16-19% is targeted from 2015.

Another Swiss specialty chemicals producer, **Lonza**, jump-started its transition from a product-oriented to a market-driven player in 2013. CEO Richard Ridinger said the elimination of low-margin business resulted in lower full-year revenues, but margins improved. While sales receded by 4.2% in Swiss francs, EBITDA rose by 4.4% and core EBIT by 11.2%. Overall, the reduction of the company's marketing footprint led to improved productivity.

Ridinger said Lonza's transformation will continue in 2014. Its new market orientation calls for concentration on key customer industries, response to global megatrends and further optimization of the portfolio. For the full year, management forecasts core EBIT growth of around 10% and revenue growth of around 5%.

At France's **Arkema**, CEO Thierry Le Henaff, said the economic environment was less favorable for the chemical company in 2013, especially in Europe sales fell 4.6% to €6.1 billion and EBITDA shrank by 9.4% to 902 million. Volume sales gained 1.4%, thanks mainly to progress in the Coatings Solutions business. Pointing to a "solid" performance Le Henaff brushed over the shrinking of the EBITDA margin from 15.6% to 14.8%. A "highly promising" number of capital spending projects started in 2013 "will bear fruit in the near future," he promised.

Despite highly divergent market conditions in world regions, the CEO said the French company "is confident in its ability to grow EBITDA in 2014." By 2016, Arkema expects annual sales of €8 billion and an EBITDA margin of 16%. Up to 2020, the respective numbers are predicted to rise to €10 billion and 17%.

For Belgium's **Solvay**, 2013 was a year of transition in which CEO Jean-Pierre Clamadieu said the stage was set for a hoped-for improvement in macro-economic conditions in 2014. Top moves were the acquisition of U.S-based Chemlogics and the separation of chlorvinyls activities to prepare for the proposed joint venture with Ineos.

Highlighting 2013 figures, Clamadieu said sales, pressured by unfavorable foreign exchange rates, decreased by 5% to €9.9 billion. The phase-out of guar and the end of the carbon credit combined to depress REBITDA by 12% to €1.67 million. For 2014, the company is "cautiously optimistic." Even in a fragile macro-economic environment, the CEO said he is confident that Solvay will see REBITDA growth. Priorities will be to complete the ongoing portfolio transformation and explore unspecified strategic opportunities.

In the Netherlands, coatings specialist **AkzoNobel** saw 2013 sales revenue shrink 5% to €14.6 billion, which it said reflected adverse currency effects. EBITDA declined by the same margin to €1.6 billion. "We indicated at the beginning of 2013 that trading conditions would continue to be challenging, and that proved to be the case," CEO Ton Büchner said. In response, he said the company accelerated its performance improvement program, concluding it a year ahead of schedule and above target.

Although AkzoNobel saw signs of stabilization in some businesses in last year's second half, the economic environment remains fragile and foreign currencies volatile, Büchner said. Plans for 2014 foresee reducing the cost base further to offset persistently soft demand. Nevertheless, the CEO said the company is on track to deliver on its 2015 targets of a return on sales of 9% and a return on investment of 14%.

Another Dutch player, **DSM**, has made progress in transforming itself into a dual-core life science and material science player. In 2013, CEO Feike Sijbesma said the company completed the third year of the strategy that "has served us well since 2010." Sales from continuing operations moved forward 5.4% to €8.6 billion. Despite persistent macro-economic challenges, EBITDA increased by 18% to €1.3 billion.

For 2014, DSM is taking "a prudent approach," Sijbesma said, assuming the unfavorable currency exchange rates will continue throughout the year. The economic backdrop is seen to continue challenging, with growth in Europe low, modest in the U.S. and slowing in the high growth economies. Management's target is to at least offset the negative currency impact.

American Chemical Producers Have Problems of Their Own

While to the economic sun appears to be shining on shale gas El Dorado U.S.A. so brightly it makes European rivals squint, American chemical producers have problems of their own. One of the most worrying to big names such as Dow or DuPont is stalking by activist shareholders seeking higher payouts.

Presenting 2013 results, **Dow Chemical** CEO Andrew Liveris took a swipe at a hedge fund urging the company to spin-off of its petrochemicals business. He said the U.S. market's largest chemical player exceeded its corporate targets despite challenging conditions – "clear evidence of our ability to manage all aspects of our integrated business to generate a strong financial performance." Total sales, excluding Feedstocks & Energy, nudged forward 1% to $57.1 billion, adjusted sales by 3%. EBITDA nearly doubled to $10.5 billion from $5.6 billion a year earlier.

For 2014, Liveris said, "while we are seeing positive trends in major economies, global growth remains tentative. Dow "will continue to allocate capital carefully, focusing on highly accretive growth projects such as new agricultural projects as well as investments on the U.S. Gulf Coast and in Saudi Arabia."

DuPont, another U.S. chemical giant pursued by an activist shareholder, lifted sales 3% in 2013 to $35.7 billion. Operating profit rose 2% to $3.6 billion. Here, Agriculture – profiting from earlier than usual orders for seeds in Q4 – stood out with an earnings rise of 16% to $345 million, while Performance Chemicals brought up the rear with a loss of $816 million.

CEO Ellen Kullman said the company's results and "strategic actions" last year reinforce its plan to build a "higher growth, higher value DuPont" and its decision to carve out Performance Chemicals – a move urged by a hedge fund shareholder. For 2014, she predicted an 8-15% rise in operating profit and a 4% increase in sales. The CEO said the outlook reflects expected improvement in global industrial production, lower agricultural input costs, and a slightly stronger average exchange value for the U.S. dollar.

Dede Williams


Kurt Bock
CEO, BASF


Marijn Dekkers
CEO, Bayer


Klaus Engel
CEO, Evonik


Matthias Zachert
CEO, Lanxess


Jean-Pierre Clamadieu
CEO, Solvay


Thierry LeHenaff
CEO, Arkema

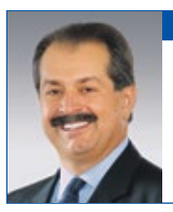

Ton Büchner
CEO, AkzoNobel


Hariolf Kottmann
CEO, Clariant


Richard Ridinger
CEO, Lonza


Feike Sijbesma
CEO, DSM


Ellen Kullman
CEO, DuPont


Andrew Liveris
CEO, Dow Chemical

Sealing Technology

New PTFE compounding technology tackles sealing challenges

Page 10

Oil & Gas Field Chemicals

Chemicals to aid the extraction of oil and gas are an increasingly profitable market

Page 12

GDUFA and the API Industry

2014 will be a telling year for the Generic Drug User Fee Act (GDUFA)

Page 13

Faster Plant Planning

Optimized Engineering Fosters Quicker Development of Chemical Facilities

Speed Through Standardization — Chemical company Evonik has been pursuing a holistic approach to plant planning for years. Strictly defined XML files within a very modular working environment form the core of this concept. All data is saved in a central database. The company is currently developing standards for piping and instrumentation (P&ID) creation with the target of uniform and accelerated plant planning.

Researchers and engineers at Evonik cooperate very closely on a global basis to facilitate a fast market launch of innovative products. Nevertheless, the planning of correspondingly tailored production plants generally still takes several years. This planning period can be minimized only when the individual planning phases are merged more closely and overlapped more intensively.

In this context, a suitable approach is the use of information generated within the scope of basic engineering throughout the further planning process. Using a procedural guideline, P&ID flow diagrams can be generated from the process flow diagrams created during this phase. The guideline should cover approximately 80% of the information contained in a flow diagram. The earlier initial P&ID flow diagrams are available, the faster initial plant costs can be calculated.

Standardization In Basic Engineering

An extensively applied standardization concept can accelerate the planning of chemical plants. Analyses implemented at Evonik Industries show that the proportion of plant parts that must be planned individually is much lower than expected. This gave a clear reason to implement standardizations in the still very complex field of P&ID creation. Time expenditures both during planning and during plant cost calculation can be significantly reduced through the introduction of standards.

"Initial discussions on standardized P&ID creation already took place 20 years ago," said Dr. Dorothea Schwarz, project manager at Evonik Industries. "However, we had to put these discussions on hold, as no suitable software tools for realizing this kind of standardization were available back then."

Holistic Software Solution for Pooling Know-How

Over time and with various software developments for plant planning, this situation has changed. Today, the chemical company employs the Comos software solution from Siemens for plant planning. Among other things, it is used for the creation of P&ID flow diagrams for individual users. This object-oriented software is based on a uniform database.

With its engineering block technology, it represents the core of the standardization concept. These eBlocks consist of a query tree and a graphical component, which adapts to the response behavior. The planners are thus reliably guided through the decision process on the basis of blocks.

At the end of the process chain, a flow diagram is generated in which every line, measurement and apparatus is interlinked with a procedural decision. Some of these decisions go into great detail. However, manual reworking may be required, especially for more complex units and genuine "know-how goodies," which constitute the specific Evonik knowledge. As the standardized queries are carried out very time-efficiently, ample leeway is available for such reworking.

We expect significantly reduced planning times as a result of the use of Comos eBlock technology.

Dr. Dorothea Schwarz, project manager, Evonik

The eBlocks form an integral part of the general planning database and are seamlessly integrated into the Comos working environment. Furthermore, data consistency is ensured at all times. As the eBlocks can be very easily supplemented by further information, every decision can be immediately assessed with regard to costs. This facilitates the rapid identification of "expensive" versions.

© Evonik

The planning of tailored chemical production plants generally still takes several years.

User-Friendly Interface for Easier Planning

The plant planners are working with a prototype developed by the chemical company. This prototype features a query tree structure, which is based on an expert system. For P&ID planning, the planners answer concrete questions on specific subjects via a user-friendly interface, for example, "Is an inflow armature required in the feed supply?" or "How many feed supplies are required in the column?"

Traffic-light colors show the user whether further planning decisions have to be made. Defined eBlocks are incorporated in the P&ID flow diagrams in accordance with the plant planners' answers. All prepared planning steps can be immediately graphically implemented and displayed by the software. All decisions made are documented and can be reversed if required.

Time Savings during Basic Planning

The application of the developed standards resulted in a considerably optimized P&ID creation process at Evonik Industries. What took half a day in the past can now be realized within roughly 45 minutes.

"We expect significantly reduced planning times with the use of Comos eBlock technology. These time savings will then be invested in developing intelligent solutions, which are matched even more closely to our customers' requirements," Schwarz said.

Furthermore, the uniform database supports interdisciplinary work flows and smoother coordination between the individual departments.

"For long-term success in this highly innovative business, we need to be able to invent products faster than others can copy them," Schwarz said.

Staff Development

At Evonik Industries, plant planning involves not only the cooperation of different colleagues all around the globe for the realization of customized plants but also includes the training of young colleagues for future tasks in the Evonik group, for example as plant engineers. Correspondingly, these persons are only assigned to the field of plant planning for a limited period. The resulting constant staff fluctuation has to be compensated for accordingly.

"It is therefore all the more important to ensure that our young colleagues can become productive workers as early as possible in this situation. From our point of view, eBlocks can make a decisive contribution to time savings for basic planning and to a faster utilization of the young engineers' creative potential," Schwarz said.

Ingo Kaiser, Manager Marketing Communications, Siemens AG

▶ Contact:
Karin Kaljumäe, Siemens AG
karin.kaljumae@siemens.com
www.siemens.com/automation

Invista Breaks Ground for HMD and PA 6.6 Plants in China

U.S. polyamide producer Invista has broken ground for a new 215,000 t/y hexamethylene diamine (HMD) plant and a 150,000 t/y PA 6.6 polymerization plant in China's Shanghai Chemical Industry Park (SCIP). Both units are scheduled to start up in 2015.

The privately owned Kansas City, Missouri-based company that bought the DuPont business and secured the nylon brand name in 2004 said the new facilities mark a key milestone in its plans for integrated PA 6.6 production in China and underscore its commitment to the region. Along with the HMD and polymer plants, Invista also plans to build a 300,000-t/y adiponitrile (ADN) plant at SCIP, which it claims will be among the most energy-efficient nylon intermediates sites in the world. Overall investment will exceed $1 billion — the company's largest capital investments to date.

Warren Primeaux, president of Invista Intermediates, said the company believes that China is driving global nylon demand growth, and the use of nylon 6.6 intermediates and polymer in the region will increase. "The new facilities will enable Invista to provide customers with better service, shorter lead time and a local resource for production," he said. ■

Bayer to Keep Brunsbüttel TDI Unit Running for Now

Bayer MaterialScience (BMS) says it will continue to operate its 125,000 t/y TDI plant at Brunsbüttel, Germany, for an undisclosed time period to meet strong demand from the markets.

The facility in northern Germany was planned to close at the end of this year after the company's new €150 million gas-phase phosgenation-based plant with capacity for 300,000 t/y starts up at Dormagen, near its Leverkusen, Germany, headquarters. Production facilities at Brunsbüttel are foreseen to be retrofitted to produce solely MDI. ■

Coim Breaks Ground for Polyols Plant in Offanengo, Italy

Italian polyester polyols producer Coim has broken ground for a new 35,000 t/y aliphatic and aromatic polyester polyols plant at Offanengo, Italy.

Completion of the facility is scheduled for September 2015, with some of the output planned to be used captively. Growing demand for Coim's polyols products will soon absorb its production capability, said CEO Lucio Siano. He said the company is "committed" to the European rigid foam insulation market as well as coatings, adhesives, sealants and elastomers. ■

Sealed With … High-Tech Plastic

Innovative PTFE Compounding Technology Tackles Sealing Challenges in the Chemical Industry

Always Adapting — Since their early days, when they were made of rawhide, radial shaft seals, rotary shaft seals or lip seals — all different names for the same component — have played a key role in the automotive and chemical industries. Of course, as chemical and automotive engineering progress, making possible what was once thought to be impossible, these little but vital elements are called upon to keep pace.

No wonder PTFE is recognized as a high-tech plastic, as its outstanding physical attributes and superb processability have helped make it the material of choice for numerous sealing challenges throughout these industries. Yet, even PTFE must adapt to meet ever-changing technological and environmental demands.

Recognizing the seal market's need for innovative materials, Dyneon, part of the 3M Advanced Materials Division, strives to stay ahead of the advances by anticipating requirements before they become acute. Through its commitment to providing new materials for sealing applications, the company has succeeded in developing and manufacturing an exciting new high-performance PTFE compound for use in the manufacture of dynamic seals, such as radial shaft seals and rod packings.

The new material, named 3M Dyneon Compound NST 1111R, offers many significant advantages for every step in the automobile industry's value chain, as well as the chemical industry, consumers and the environment. The innovation constitutes a major breakthrough and promises to make possible a multitude of solutions that will be useful to meeting today's and, more importantly, tomorrow's sealing challenges.

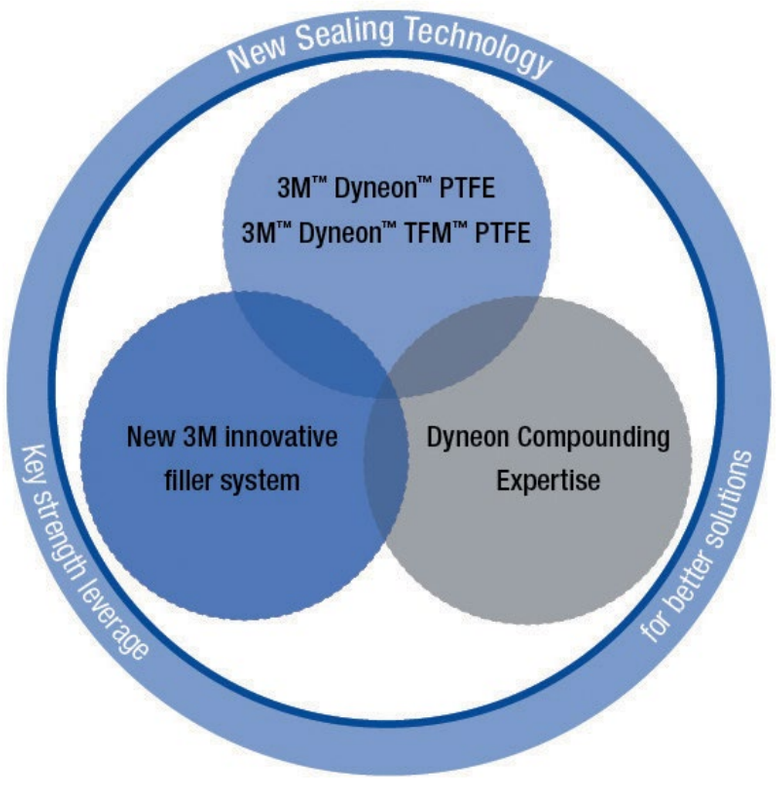
Compounding Expertise Is Key

Until now, PTFE compound lip seals have usually contained fiberglass, which, although strengthening the seals, left much to be desired because of the fibers' irregular form and disorientated configuration within compounds. NST 1111R, the first advanced PTFE compound in Dyneon's New Sealing Technology (NST) portfolio, shows significantly improved features, such as a lower permeation and improved wear. It also complies with the requirements for sealing applications.

Dyneon NST 1111R is the product of compounding Dyneon's high-performance PTFE with 3M solid ceramic microsphere fillers, an effort that required a sizeable financial investment for the development, significant time and a great deal of technical knowhow. However, the outlay was worth every cent.

To unleash the enormous potential of this new material, though, 3M had to master several challenges first. For example, one of the biggest challenges encountered in trying to compound the micro-sized 3M Microspheres with PTFE was the spheres' inherent tendency to agglomerate.

Having overcome this hurdle, 3M contracted an independent testing institute (the University of Stuttgart's Institut für Maschinenelemente) to test the new material. Both these and other tests performed at Dyneon's facility in Kerkrade, Netherlands, confirm, among several other key improvements, the superiority of NST 1111R over the conventional PTFE-fiberglass-filled compounds. The reference materials used for the comparative tests were the standard Dyneon PTFE-fiberglass compounds used in the application today: 3M Dyneon PTFE Compound TF 4105, containing 25% fiberglass, and TF 6711, containing 5% glass fibers and 5% molybdenum disulfide.



Dynamic Seal Applications

The tests performed by the Institut für Maschinenelemente clearly demonstrated that with NST 1111R it is possible to reduce lip seals' thickness to 0.5 mm and 0.65 mm from today's commonly used 0.8 mm, thus lowering the radial load and consequently the friction torque. Even with these reduced lip-seal thicknesses the findings proved a significantly reduced leakage rate compared with the reference material (Dyneon TF 4105). All PTFE compound test specimens showed only minor wear after the 240-hour endurance tests.

"The new material clearly outperformed the conventional materials in our tests, displaying superior durability, lower friction torque, lower leakage rate while using less material," said Professor Werner Haas, director of the Institut für Maschinenelemente. For dynamic radial applications in the automotive and chemical industries, the test results are welcome news, confirming that NST 1111R has a bright future, whether as a seal for axles, or hydraulic or chemical pumps.

The list of Dyneon NST 1111R's advantages compared with Dyneon TF 4105 is long, including 17% lower friction coefficient for better economy, greater component durability and life-cycle time, as well as longer service intervals and 13% greater thermal conductivity — which leads to enhanced heat dissipation. Particularly useful to the chemical industry are the new material's significantly lower leakage rate, and a 98% improvement in permeation, based on tests using helium. The material shows improved tear resistance as a result of the ceramic microspheres' smooth and round geometry.

Static Seal Applications

In general NST technology's improved permeability is also very welcome in static seal applications, as is its excellent deformation-underload performance. Therefore, in still another new product development, Dyneon will announce the launch of its second sphere-filled PTFE, this time with 3M Glass Bubbles, microscopic hollow glass spheres. This PTFE compound is engineered specifically for static applications in the chemical industry.

Processors Have a Lot to Gain

"3M's microspheres' uniform roundness permits significantly better processing of NST 1111R into and from billets or rods, providing smoother surfaces, which is an enormous benefit to processors, allowing them to save considerably on knife and knife-sharpening expenses," said Gerd Beul, Dyneon marketing manager for general industry. "Another clear-cut advantage for processors is improved material utilization."

NST 1111R's superior physical properties allow processors to reduce waste and the amount of raw material per manufactured unit, thus boosting the efficiency and environmental performance of their operations.

There's More To Follow

Like our world, technology that improves the quality of our lives — directly or indirectly — never stands still. For this reason, even materials like PTFE compounds require further innovative development to remain viable solutions to future sealing requirements. Dyneon's New Sealing Technology portfolio is being developed to meet exactly these needs. NST 1111R, a compound engineered for automotive and chemical industry applications, is the first of what promises to be many more high-performance PTFE compounds. The next product is already on its way, featuring 3M Glass Bubbles and holding great promise for static sealing uses. And especially interesting: All the PTFE compounds may be varied to meet specific sealing application and processing requirements.

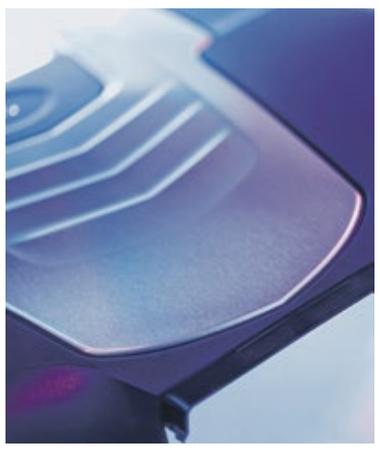
Gerd Beul, marketing manager for general industry, 3M
Robert Veenendaal, application and product development, PTFE Compounds Europe, 3M

▶ Contact:
Dyneon GmbH
3M Advanced Materials Division
Neuss, Germany
dyneon.europe@mmm.com
www.dyneon.eu

Innovative Bonding with PIT

A Technology for More Than Just Quality Surfaces

Plastics Interface Technology (PIT) — is a patented technology for the bonding of various decorative materials with a polymer substrate. Developed by the PP Compounding group of LyondellBasell, this new technology enables the cost-effective manufacturing of structures with excellent surface qualities for a range of applications in appliances, electronics and automotive.



The production of a plastic substrate including a metal foil can be achieved by various methods. Existing methods; such as, gluing, electroplating or spray painting can sometimes require additional extensive manufacturing steps to finish the final component. A new patented technology combines a plastic substrate with metal or foils of other materials in a simple one-step operation. The PIT makes use of decorative foil that is pre-coated with a binder material and that is placed directly into the injection mold or pressed or welded with the substrate to form a permanent bond. The PIT process offers a wide potential for many applications as many materials can be processed. Paper, foil, cork, veneer, leather, linoleum, glass; as well as, stainless steel and aluminum could be used as possible decorative materials. The potential list of applications for the appliances, electronics and automotive segments are diverse as the many different materials that can be processed along with the decorative elements. In addition, self-supporting compounds can be produced that combine high strength with weight saving.

Compounds produced with PIT not only offer very good optical properties and functional surfaces, but also demonstrate mechanical and thermal properties that exceed those of the substrate material alone. In trials carried out in cooperation with customers, PIT composites have confirmed their toughness and long-term resistance to mechanical and chemical attack, even in demanding applications involving exposure to the hot detergent solutions found in washing machines and dishwashers. This technology has the potential not only to revolutionize the production process but to also saves valuable resources. All compounds can be separated by temperature between 200 and 300 °C and are fully recyclable.

"Silver-touch" for Polypropylene

Especially interesting is the use of aluminum foils on polypropylene substrates. One obvious area of application for the new composite material is in the replacement of electroplated engineering plastic. Initial trials with an aluminum-polypropylene compound show the potential for significant cost savings by eliminating the process of electroplating to achieve a surface quality that is comparable or superior. In addition the reject rates are lower as the aluminum foil is less prone to surface errors.

Another area of application for a metal foil on a polymer substrate includes the provision of electromagnetic interference (EMI) shielding in electrical appliances or electro mobility. The high thermal resistance of the PIT composite can offer excellent flame-retardancy with a full compliance of the requirements of flammability classes B1 and B2 or UL94 V-0. IT compounds also offer weight saving opportunities in comparison to steel in the building and construction, elevators and automotive industry.

First time applications are already in production or are close to being commercialized. Potential new areas of application are currently being identified and evaluated. For example, lightweight polypropylene tiles with a decorative surface cover could be used to open up new possibilities for the home and furniture industry. Additionally, foamed PP compounds could be combined to enhance these decorative surfaces adding new dimensions with additional weight saving possibilities. Another application is thermal resistance by adding aluminum foils. It makes this technology attractive for lamps or even toaster housings. In automotive applications, PIT compounds can be used in interior (soft touch door covers, center console with veneer surface), exterior (chrome trims) or under-the-hood (engine covers) applications. PIT can also help reduce metal thickness — and therefore, weight — when foamed PP compounds are used. Caravans have the opportunity to replace wood components.

PIT composites have the potential to offer unprecedented levels of cost-performance in a wide area of application. Using this technology, the requirements of an economic production of lightweight components with high surface quality can be easily met with virtually unlimited possibilities.

▶ Contact:
Dr. Erik Licht
LyondellBasell, Frankfurt/Main
Tel.: +49 69 3058 5840
erik.licht@lyondellbasell.com
www.lyondellbasell.com

Membrane Reactors

Utilizing More Than One Membrane in a Reactor Imparts Additional Functional Capabilities

Industrial Chemistry — Of the many types of membrane processes available for separation, membrane reactors have been studied using reverse osmosis (RO), nanofiltration (NF), ultrafiltration (UF), microfiltration (MF), electrodialysis (ED), liquid membranes (LM), pervaporation (PV), gas permeation, vapor permeation, molecular sieving, Knudsen diffusion (and molecular diffusion), gas membrane, membrane solvent extraction, and membrane gas absorption/stripping.

Membranes are employed as flat films, hollow fibers, tubules, and tubes, while their physical structures can be as follows: microporous symmetric and asymmetric membranes, nonporous membranes, and composite membranes. Membranes can be of the polymeric variety or be inorganic in nature, which would include zeolitic, ceramic, and metallic membranes. Membranes can also conduct electrical charges and can be chosen from one of the following categories: ion-exchange membranes, bipolar membranes, mixed-conducting membranes, proton-conducting membranes, etc. In many cases, the membranes have catalysts incorporated in their porous structure or on the surfaces. The membranes in such cases are termed as catalytic membranes.

Functions of a Membrane in a Reactor

Of course, the membrane can be catalytic by itself without the addition of any catalyst materials from external sources. The term catalytic membrane reactor sometimes includes the above cases as well as a catalytic reactor enclosed by a membrane, which is noncatalytic. Figure 1 schematically identifies major generic functions performed by a membrane in a reactor. Of course, a given membrane in a given reactor is not capable of all functions illustrated in Fig. 1. However, a given membrane under appropriate circumstances can perform more than one generic function. The introduction of another membrane into the reactor can increase the number of generic membrane functions in the reactor or achieve the same generic membrane function in comparison to some other species. Fig. 1 also indicates other phenomena concurrently taking place in the so-called nonreactor- (or permeate-) side of the membrane as well as in the reactor-side of the membrane.

Generic functions performed by membranes in reactors are:

- Separation of products from the reaction mixture (Fig. 1a), in order to drive equilibrium-limited reactions to higher conversion, to suppress undesired side reactions, to increase the selectivity in consecutive reaction schemes, or to enhance reactions by removal of inhibiting products
- Separation of a reactant from a mixed stream for introduction into the reactor, in order to concentrate reactants prior to chemical reaction or to reject inhibiting species (Fig. 1b)
- Controlled addition of one reactant or two reactants, in order to enhance the yield of desired intermediate products, and to avoid thermal runaway of strongly exothermic reactions (Fig. 1c). This has been demonstrated in many works for gas-phase, for gas–liquid, and for liquid-phase reactions
- Nondispersive phase contacting with microporous/porous hydrophobic membranes (with reaction at the phase interface or in the bulk phases) (Fig. 1d). This technique has been employed in fermentor-extractor systems], enzymatic fat splitting, phase transfer catalysis, and extractive membrane bioreactors for enzymatic resolution of isomers
- Segregation of a mobile catalyst in a reactor via ultrafiltration or nanofiltration membranes, i.e. enzymes and cofactors in biocatalysis, and homogeneous catalysts in organic syntheses (Fig. 1e)
- -mmobilization of a catalyst in (or on) a membrane, e.g., enzymes or whole cells for biocatalysis, and oxides or metals for chemical synthesis (Fig. 1f)
- Membrane is the catalyst, if the membrane material is inherently catalytically active such as cation-exchange membranes for esterification reactions or palladium membranes for dehydrogenation reactions (Fig. 1g)
- Membrane is the reactor, i.e. the bulk flow of a reaction mixture takes place through a porous/microporous membrane from one membrane surface to the other (Fig. 1h)
- Solid-electrolyte (SE) membranes (in particular conductors for H+ or O2-) support electrodes, conduct ions, and achieve the reactions on their surfaces. This concept is the basis of fuel cells and electrolysers (Fig. 1i)
- Transfer of heat, e.g., when coupling endothermic and exothermic reactions(Fig. 1j)

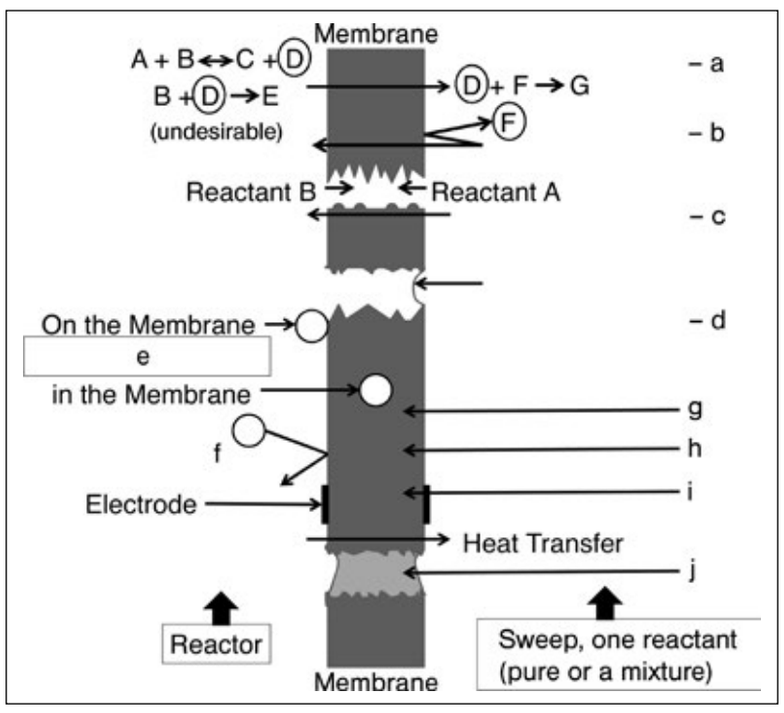


Figure 1. Schematic of possible functions of a membrane in a reactor [adopted from K.K. Sirkar, P.V. Shanbhag, A.S. Kovvali, Ind. Eng. Chem. Res. 38 (1999) 3715]
a) Product selectivity removed; b) Purify reactant A from species F before addition; c) Distribute reactant A in a controlled fashion; d) Phase interface immobilized in a contactor–non-dispersive contacting; e) Immobilize catalyst; f) Retain catalyst in reactor; g) Membrane is the catalyst; h) Membrane is the reactor; i) Solid electrolyte membrane supports electrodes, conducts ions, and reactions on surface; j) Immobilized liquid reaction medium

- Immobilizing the liquid reaction medium in the pores of a membrane (often termed as supported liquid membrane, SLM (Fig. 1k)

Membrane Reactor Configurations

Membranes in a reactor existing as membrane laminates or physically separated membranes with a fluid phase in between have also been studied. They can provide particular combinations of the above functions sometimes with added and novel benefits including product separation and simultaneous concentration, separation of multiple products, reaction intensification, and physically containing the reaction medium in multiphase reaction systems.

Often the membrane is physically located in a device external to the reactor. The reaction medium is then circulated over the membrane and back to the reactor in a recycle mode. This configuration is frequently employed in reaction processes based on enzymes and whole cells; it is also being proposed for organic syntheses. The reactor vessel in such case is sometimes operated as a batch reactor or more frequently as a continuous stirred-tank reactor (CSTR). In many circumstances, the system behavior here can be considered to be equivalent to that with a membrane located directly inside the reactor. Major advantages of these different arrangements are:

- The mixing conditions and the flow velocities (and therefore the extent of consequent concentration polarization in membrane devices involving liquid–phase systems) can be maintained at different levels in the reactor and the membrane separator if recycle membrane reactors are employed; conditions can be optimized for each. The reactor may require long residence times whereas the membrane device may need a short residence time
- Building a reactor with a membrane in it or using a membrane device as the reactor can sometimes be very demanding on the membrane, especially for high-temperature systems. The recycle membrane reactor allows the reactor and the membrane unit to operate at two different temperatures by using heat exchangers in between
- Recycle membrane reactors allow the use of existing equipment, namely, a separate reactor and a separate membrane device
- For fast reactions, the "membrane-in-a-reactor solution" is likely to be a more desirable configuration

Membrane Reactor Applications

Many investigations on membrane reactors have been conducted in biochemical processing, petrochemical applications, and environmental pollution control. A few processes employing polymeric membranes have been commercialized. Utilizing more than one membrane in a reactor imparts additional functional capabilities. For effective large-scale utilization of the diverse functional capabilities of a membrane in a reactor, considerable research and development on membrane lifetime, available space-time, module design, membrane fouling, membrane poisoning, and membrane cost are essential. This is especially true for inorganic membranes and higher-temperature applications where the hurdles for industrial use are considerable.

References are available from the authors upon request.

Dr. Hannsjörg Freund,
Max Planck Institute for Dynamics of Complex Technical Systems, Magdeburg, Germany

Prof. Kai Sundmacher,
Max Planck Institute for Dynamics of Complex Technical Systems, Magdeburg, Germany; and Otto-von-Guericke University Magdeburg, Germany

Read more about this topic in Ullmann's

This article is an excerpt from the Ullmann's Encyclopedia of Industrial Chemistry (wileyonlinelibrary.com/ref/ullmanns) which celebrates its 100th anniversary in 2014. More about the topic can be found in the encyclopedia article on **Process Intensification, 4. Plant Level**. More concept articles on general interest topics in industrial chemistry and chemical engineering can be found on the Ullmann's Academy homepage (just scan the Code).

SCIP Industrial Gases Wins Long-term Supply Contract in China

Shanghai Chemical Industry Park Industrial Gases Company (SCIPIG), a joint venture of U.S. gases manufacturer Praxair and French partner Air Liquide, has been awarded a 15-year contract to supply industrial gases to Shanghai SECCO Petrochemical Co in the Shanghai Chemical Industry Park (SCIP).

As part of the deal to provide large volumes of pure oxygen for SECCO's sulfuric acid regeneration unit, SCIPIG will build a new 900 t/d air separation unit and an integrated liquefier at the Chinese site by 2015. Along with increasing capacity, the investment will significantly reduce emissions and improve overall production efficiency, the joint venture said. Additionally, SCIPIG will extend its pipeline network in the chemical industry park. The gases JV established in 2013 has production capacity for more than 200,000 cbm/hr of various industrial gases and claims to have one of the largest industrial gas production bases in China and Asia. (dw) ■

Foster Wheeler Wins OMV Services Contract, Buys Siemens Unit

Swiss-based global engineering and construction group Foster Wheeler has signed a five-year alliance agreement with Austrian oil and petrochemicals giant OMV to provide integrated project management and engineering, procurement and construction management services.

Under the deal, the group - soon to be acquired by UK Engineering group AMEC — will provide services on a privileged basis through specific work orders for the OMV refineries located in Burghausen, Germany, and Schwechat, Austria. These include front-end loading for projects of any size as well as engineering, procurement and construction management services for projects up to a specified threshold limit with respect to Total Installed Cost.

Separately, Foster Wheeler has announced plans to acquire Siemens Environmental Systems and Services business from Siemens Energy. Terms of the deal expected to close in the second quarter of 2014 were not disclosed. (dw) ■

Lurgi Now Trading as Air Liquide Global E&C Solutions

Air Liquide has fully absorbed its German engineering subsidiaries Lurgi and Zimmer. Going forward, the two companies added to the French industrial gases group's portfolio in 2007 will be known as Air Liquide Global E&C Solutions. Lurgi will be operated as a division of Air Liquide within the Large Industries business segment, and its financial results will not be reported separately. In 2013, the business had sales of around €15 billion. (dw) ■

Oil- and Gas-Field Chemicals

Fluctuating Energy Prices and Interruptions to Production Can Undermine Strong Growth in Demand

Soaring Costs — For a rising number of chemical companies, an increasingly profitable market is the sale of chemicals to aid the extraction of oil and gas from deep and geologically complex reservoirs. Production from these difficult locations is accounting for a growing proportion of the world's oil and gas output. But its costs are soaring.


© Kotkoa - Fotolia.com

This is good news for companies in the oil- and gas-field chemicals market because their products — from surfactants, defoamers and demulsifiers to gels and polymers — are accounting for a rising percentage of these production costs.

The global oil and gas services market for chemicals — which includes well additives such as drilling fluids or muds and cementing chemicals, as well as pipeline chemicals such as anti-corrosion and cleaning products — is worth around $5 billion to $6 billion annually and growing by an average of 4% per year.

This represents only 1% to 2% of the total $350 billion oil and gas services sector, a high proportion of which comprises the provision and operation of engineering equipment. But with some wells the share of costs taken by chemicals can be considerably higher.

Risks in Oil and Gas Services

For chemical companies investing in the sector, particularly through acquisitions, there are pitfalls. One of the largest of these is the possibility that oil prices will tumble to a level well below the prevalent benchmark price of North Sea Brent crude — around $100 per barrel. A steep decline would make oil and gas fields with high production costs and a big use of chemicals uneconomic.

Another risk, less drastic than a long-term weakening of oil prices, is a period of sharp fluctuations in supplies of oil and, to a lesser extent, natural gas for economic, political or safety reasons.

In 2010, the Macondo blowout at the Deepwater Horizon drilling rig, which killed 11 people and caused an oil spill of nearly 5 million barrels, prompted a six-month drilling moratorium in the Gulf of Mexico, one of the world's largest offshore centers of oil and gas production. For suppliers of chemicals to the area, demand disappeared overnight.

In addition, it is a highly competitive sector technologically so that R&D capabilities are crucial. Nonetheless technological expertise by itself is not sufficient.

Successful chemical companies in the sector need to be able to distribute their products directly or indirectly to well heads with a local technical backup. Since oil and gas reservoirs are often in remote areas, many of them offshore, this requirement for on-site services can be difficult and expensive to fulfill.

Untraditional Methods

The big driver behind the increasing demand for chemicals is a switch to production methods other than the traditional ones of natural pressure and water injection to bring oil and gas to the surface.

Instead, due to a large proportion of existing recoverable oil and gas being in deep offshore water reservoirs or in tight rock formations, complex enhanced oil recovery (EOR) systems have had to be applied. These include the chemical-assisted application of steam, CO_2 and other gases; chemical-based methods using polymers and surfactants; and use of microbes.

By next year, deep-water drilling will account for 25% of offshore oil production, which makes up around half of total oil output globally, according to Clariant, a Swiss-based specialties chemical company and one of the world's leading oil-field chemical producers. By 2025 the deep-water share of offshore output will have risen to half and to 25% for all oil production.

The Edinburgh-based consultancy Wood Mackenzie predicts that expenditure on deep-water drilling will rise by more than 2.5 times from $43 billion in 2012 to $114 billion in 2022. The rising spending looks likely to continue well into the 2020s since over the last decade the deep-water sector has accounted for 41% of newly discovered oil volumes, according to Wood Mackenzie.

Deep-water operations require a wide range of chemicals in addition to surfactants and polymers, such as emulsifiers and demulsifiers, flow stimulants, dispersants and scale, corrosion and hydrate inhibitors. These have to be able to function in extreme conditions, in particular in high temperatures, pressures and salinity, and with heavy and other unconventional oils.

They also have to comply with tough environmental regulations and safety standards, which are tending to be applied uniformly throughout the world. These have become even stricter after the Macondo accident, even in developing countries such as West African states.

"Safety is the number one priority with all activity being focused on reducing risk," John Dunne, Clariant's vice president, general manager of oil and mining services, told a recent company news briefing in Zurich. "With the environment, there are increasing regulatory controls associated with chemicals applied in deep-water operations. We have to offer solutions which have a big focus on environmental protection and sustainability."

More Than Chemicals

Oil-field chemical suppliers like Clariant also have to back up their business in the sector with a worldwide network of manufacturing plants and services centers.

"A very important aspect of the oil chemicals business is to have a presence where your customers are," Dunne said. "You have to be able to respond quickly to customer needs."

The chemicals provided to meet these requirements have often to be versatile to deal with local conditions and to be innovative.

"Difficult requirements call for an innovation-driven company," Dunne said. "It's important for an oil-field chemicals business to be part of a large chemicals company with big R&D capabilities. We have, for example, adapted a personal care compound developed by Clariant to aid oil production."

Strategic Takeovers

Chemical companies have been making a growing number of strategic takeovers in order to obtain technologies or a stronger regional presence in the sector. In most cases these have been add-on acquisitions. Critical mass can be a major competitive advantage in a market in which big services companies, such as Halliburton, Baker Hughes and Schlumberger, all based in Houston, Texas, develop and supply chemicals. Some of the international (IOC) and national (NOC) oil companies also have chemicals operations.

Ecolab in St. Paul, Minnesota, a global leader in water, hygiene and energy technology services, has in recent years emerged as a major player in oil- and gas-field chemicals through acquisition. First it took over in 2011, in a $5.4 billion deal, Nalco Holding Co., Naperville, Illinois, a producer of chemicals for water treatment and pollution control in the oil, paper and other sectors.

Then in October 2012 it agreed to acquire for $2.2 billion Champion Technologies, Houston, a big global supplier of specialty oil-field chemicals with employees in 30 countries.

General Electric Co. (GE) is now a leading operator in oil and gas production after building up a strong presence through its divisions of GE Oil and Gas and GE Water and Process Technologies, through which it is a big provider of chemical solutions. The GE Oil and Gas business has grown rapidly over the past 10 years after more than 30 acquisitions.

Mergers and acquisitions in oil- and gas-field chemicals have been frequent in the last few years in the U.S., which as a result of the shale oil and gas boom is forecast to overtake Saudi Arabia to become the world's leading oil producer by 2020.

M&A activity has helped to stimulate a lot of technological innovation, not just in the development and formulation of chemicals but also in their distribution. The oil and gas sector has as a result become an area of expansion for distribution specialists both in North America and worldwide.

nivar Inc., Redmond, Wash., for example, has been building up a strong presence in the global sector — not just in North America and Europe, where it is already a major distributor in the whole chemicals market, but also in South America, the Middle East, Africa and Australia.

"Our focus (in oil and gas) is on innovative transportation options to get the right chemicals to the right place at the right time," said Chris Oversby, president, Univar Oil, Gas & Mining. "On-site, real-time delivery is changing the way oil and gas companies and the broader industry view distribution. Time is critical at the well site."

The company reckons it is helping small and medium-size enterprises (SMEs) in chemicals enter the unconventional oil and gas segment, especially shale gas production in North America where many shale basins are located in remote areas.

"We can give smaller companies access to world class chemicals that are generally only available in very large batches," Oversby said.

Beyond The Basics

Distributors such as Univar are also extending their activities in the oil and gas sector beyond the storage and transportation of chemicals to their blending and formulation at the production site. It acquired in December 2012 Texas-based Magnablend, a custom chemicals manufacturer and blender for the oil and gas market.

"Magnablend focuses on manufacturing products for each customer's individual specifications and assists in the development of new chemical formulations for the well site," Oversby said.

As oil and gas production becomes more intricate with the types of chemicals used being dictated by local conditions, the sector will increasingly offer openings to flexible specialty chemical companies and distributors with a skill for on-site formulations. The market for oil- and gas-field chemicals is thriving but it is also becoming much more fragmented.

Sean Milmo, freelance science and business journalist, Essex, United Kingdom

Oxea Plans Capacity Increase for Plasticizer Oxsoft GPO

In order to meet strongly growing customer demand, Oxea is planning to increase its European capacity for Oxsoft GPO by 50,000 t/y by the fourth quarter of 2015. To this end, Oxea has signed a Memorandum of Understanding with an unnamed party to establish a joint production of dioctyl terephthalate (DOTP), a general-purpose plasticizer used in a wide range of applications such as construction, automotive and flooring.

"The European market for phthalate-free plasticizers is growing rapidly. As a replacement mainly for dioctyl phthalate and diisononyl phthalate, DOTP is benefiting particularly from this development and our capacities need to be planned correspondingly," said Oxea's project leader, Christian Boehmer.

Jacco de Haas, global marketing manager for Specialty Esters, said: "Oxea is integrated into key raw materials for DOTP. For example, Oxea is the largest European producer of 2-Ethylhexanol, which is the main raw material for the production of DOTP." (dw) ■

BASF Total JV Starts 10th Cracker Furnace at Port Arthur

BASF Total Petrochemicals, a 60:40 joint venture of BASF and French oil and petrochemicals group Total, has started up a tenth furnace at its Port Arthur, Texas, steam cracker.

The additional furnace, said to increase nameplate ethylene capacity to more than 1 million t/y, improves feedstock flexibility, enhances plant reliability, and enhances the JV's commitment to Port Arthur, the partners said. In 2013, the Texas cracker was converted to run on light-feed ethane derived from U.S. shale gas.

"These recent investments in the steam cracker allow the plant to produce more than 85% of its ethylene based on cost advantaged feedstocks," said Philippe Doligez, senior vice president for Total Refining & Petrochemicals Americas. "Along with increased capacity, the new furnace reinforces the availability of the plant," he added. (dw) ■

Air Liquide Starts U.S. Nitrogen Gas Plant

French industrial gases producer Air Liquide has started up a new nitrogen gases plant at Tioga, North Dakota, in the U.S. The new facility will increase supply to drilling operations in the oil-rich Bakken reserves. The new facility has capacity to produce 100 t/d of gas.

"We continue to position ourselves to better support this growing oil and gas region," said Wayne Bohannon, president, Air Liquide Industrial U.S. "The growing demand for nitrogen in this region coupled with the booming oilfield services activity there and in other regions of the U.S., aligns well with our offers and capabilities and our growth and expansion plans to serve this industry," he added.

Air Liquide claims the use of liquid nitrogen and carbon dioxide in the exploration process can displace the use of water by upwards of 50%, lending "significant production and environmental benefits to traditional methods." (dw) ■

Addivant to Expand Saudi Gulf Stabilizer Plant

Addivant has announced the completion of the first phase of capacity expansions at Gulf Stabilizers Industries (GSI), the company's joint venture in Al Jubaïl, Saudi Arabia. Once completed, the production capacity of hindered phenolic antioxidants, Anox 20 and Anox PP18 and, phosphite antioxidant Alkanox 240 will double to 10,500 t/y.

GSI's board of directors also announced that plans are underway to expand production capacity of the Anox NDB product line to 24,000 t/y to meet growing customer demand for a range of new, higher performing products.

GSI is a joint venture between Addivant and Zamil ChemPlast, one of Saudi Arabia's leading industrial manufacturing companies.

"The rapid expansion of the Middle East polymer industry over the past two decades has been impressive and it will continue in the years ahead with the downstream markets playing an increasingly important role," said Peter Smith, Addivant CEO and GSI Chairman of the Board. (dw) ■

GDUFA and the API Industry – an Update

This Year Will Be a Telling One for GDUFA and its Effects on the Future of the Generic Drug Industry

The Price of Doing Business

— Following the 2012 implementation of the Generic Drug User Fee Act (GDUFA), an article in CHEManager Europe's July/August 2013 edition about GDUFA's Impact on the API Industry. The article summarized the legislation and outlined the FDA's intended outcomes along with other potential consequences resulting from the new regulations and associated fees. The legislation has now been on the books for over a year, and while more time is needed for the long-term effects of GDUFA to be fully realized, some initial trends have begun to emerge.

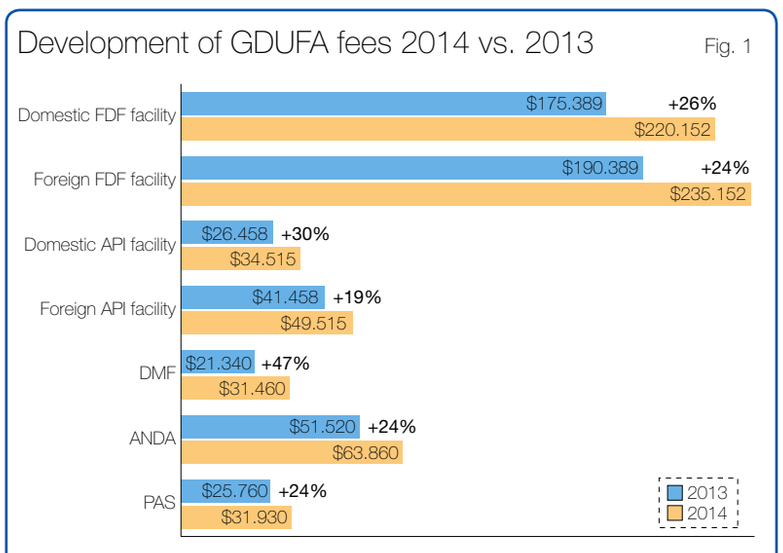

© Africa Studio - Fotolia.com

FDA On Track

The FDA has met all of the GDUFA first year commitments outlined in the "Generic Drug User Fee Act Program Performance Goals and Procedures". GDUFA brought in approximately $296 million during FY2013, just below the annual target of $299 million. The FDA adjusted FY2014 drug master file (DMF) and facility fees based on inflation and amounts received during the prior year (Fig. 1); these adjustments will be made each year throughout the life of the program. The FDA exceeded its goal of hiring and training 25% of total GDUFA program hires; 250 employees (approximately 30% of GDUFA program hires) came on board with over 100 assigned to the office of generic drugs (OGD), an FDA "super office" that has made GDUFA implementation its top priority. Improvements to the FDA's review processes for ANDAs and Prior Approval Supplements (PASs) have been made and while there remains a stack of these applications to be reviewed, the FDA has made initial progress toward reducing both the current backlog and future review times.

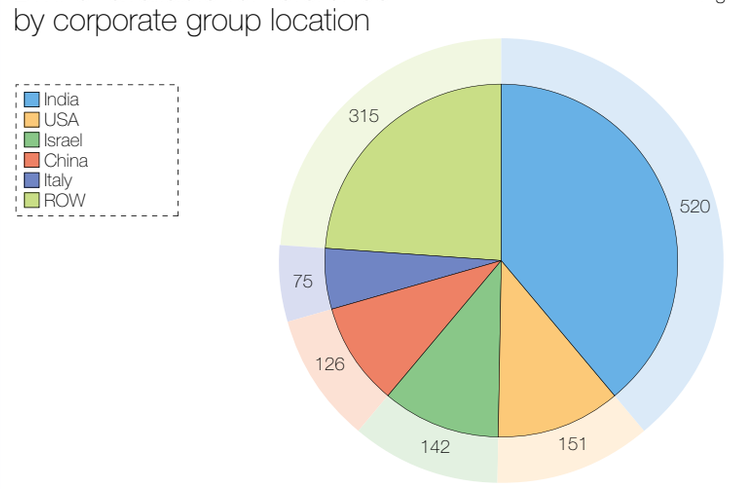
FDA officials have praised the generic industry for prompt fee payment and self-identification during GDUFA's inaugural year. The agency has begun developing an inventory of manufacturing establishments and products that they plan to make accessible online in the near future.

Development of GDUFA fees 2014 vs. 2013 — Fig. 1



Source: Thomson Reuters © CHEManager International

DMFs "available for reference" by corporate group location — Fig. 2



Source: Thomson Reuters © CHEManager International

Industry Trends

At the time of this writing, 1,329 DMFs have been filed, paid for and made "available for reference" under the new GDUFA system (Fig. 2). India was by far the most prolific filer with Indian-based companies accounting for 520 DMFs. India's percentage of the total DMF filings (39%) is very much in line with what was seen during the pre-GDUFA decade. However, only 126 DMF filings originated from China since the GDUFA implementation, which is a sharp downturn from a year ago when Chinese API manufacturers accounted for nearly 20% of DMF filings. The 142 Israeli DMF filings are the result of Teva Pharmaceuticals proactively paying filing fees on a large portion of their API portfolio; this should be a one-time spike and not a trend toward greater API production in that nation. Total DMF count is not a direct measure of regional API production or presence in the US market, especially considering that DMF fees were not required to be paid until the first new DMF reference in a drug application after GDUFA implementation. It will be interesting, however, to continue to monitor DMF filings by country to determine whether nations in less regulated markets have slowed their prolific filing rates in response to new fees as well as the challenge of preparing for and responding to FDA inspections.

Despite the difficulties of training new staff and obtaining foreign work visas, the FDA has increased its level of scrutiny in less regulated markets. FDA staff increases in India and, very recently, China, along with increased inspections from US-based staff, will no doubt result in increased depth and frequency of manufacturers in these less regulated markets. Several large Indian API producers, namely Ranbaxy and Wockhardt, have already seen products banned from US import following unsatisfactory inspection reports; with US officials finally obtaining permission from the Chinese government to increase FDA presence there, we can expect this market to be the next to fall under the FDA's regulatory spotlight.

Value for Small Companies

GDUFA fees have proven burdensome for small generics companies. The new legislation will eventually provide value for small companies and first time entrants to the market through reduced review times and earlier drug launches, however, these benefits are still several years away. Representative Robert Hurt (R-VA) introduced a bill designed to bring some relief to small companies required to pay the same DMF and facilities fees as large companies. The "Small Manufacturer Protection Act of 2013" would allow for waivers and refunds in cases where fees represent a significant barrier to market entry due to limited resources.

Without financial relief in the form of GDUFA fee waivers, small companies may need to trim their API portfolios and specialize in products with some barrier to market entry which limits competition. Additionally, the recent wave of mergers and acquisitions is likely to continue as small innovative generics companies are "bolted on" to large established firms with the capital to gain market entry.

GDUFA fees have proven burdensome for small generics companies.

Michael Glessner, Pharmaceutical Research Analyst, Thomson Reuters

Moving Forward

This year will be a telling one for GDUFA and its effects on the future of the generic drug industry. The ANDA backlog should finally begin to shrink and many companies in less regulated markets will determine whether they can meet FDA standards. An increase in DMF filing fees and annual facility fees may now prove prohibitive to companies wishing to enter the U.S. market, any API or finished dose manufacturers leaving the U.S. market would lead to further increases in annual facility fees. U.S. consumers should be the biggest winners as GDUFA has entered its second year - increased regulations and transparency for foreign API producers will mean safer, higher quality generics medicines.

Contact:
Michael Glessner
Thomson Reuters
Portland, Maine, USA
Tel.: +1 207 871 9700 Ext. 21
michael.glessner@thomsonreuters.com
www.thomsonreuters.com

DSM, Patheon and Banner Form Pharma Services JV

PHARMA — JV of DSM and JLL Partners is named DPx Holdings

DPx Holdings, the new global contract development and manufacturing joint venture of Dutch chemical producer DSM with U.S. private equity firm JLL Partners, was launched on March 11. The company headquartered at Durham, North Carolina, and owned to 51% by JLL results from a $2.65 deal between the private equity group and the chemical company announced in November 2013. With more than 8,000 employees at 24 locations on four continents, it expects $2 billion in annual sales.

With businesses put together from the assets of DSM Pharmaceutical Products, JLL-owned Patheon and Banner Life Sciences, DPx will be the corporate parent of three distinct brands focused on pharmaceutical services, fine chemicals and proprietary products and technologies.

Pharmaceutical Services will be grouped under the Patheon name and will include commercial manufacturing capabilities, pharmaceutical product development serves as well as biosolutions and biologics.

Fine chemicals, including the ES/IM and active pharmaceutical ingredients (APIs) business, will trade as DSM Fine Chemicals.

Proprietary products and technologies will be operated under the Banner Life Sciences name.

While Patheon will be an integrated supply model, offering a full range of drug development and manufacturing services, DSM Fine Chemicals will handle complex APIs and finished dosages. Banner Life Sciences will supply its own proprietary and nutraceutical products.

In announcing the plans late last year, the prospective partners said Patheon CEO Jim Mullen, would be CEO of the new venture. At the time, Mullen told journalists that his company's customers „have indicated a strong desire to streamline their outsourcing network and at the same time, increase their outsourcing", adding that „they want to work with fewer companies with broader capabilities."

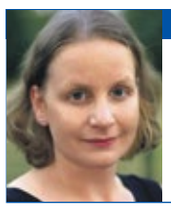
DSM, world leader in vitamins, has spent more than €2.2 billion since 2010 buying into less cyclical businesses such as food ingredients and high-end plastics, and moving away from lower-margin bulk chemicals. ■

In Search of a Safer, Greener Firework

Change Is Needed in an Industry with a Higher Incidence of Accidents than Most

Risks of Lighting Up the Sky

— As the dust settles — quite literally — following the traditional New Year celebrations in the Western and Chinese-speaking worlds, fireworks have again hit the headlines for all the wrong reasons. There are two major problems: safety and pollution.



Dr. Alana Collis
IChemE

© licht75 - Fotolia.com

As far as safety is concerned, 2013 was a bad year in the fireworks industry. There were eight known accidents in firework factories worldwide, in China (three), India (two), Italy, Canada and Vietnam, killing at least 48 people and injuring more than a hundred.

Poor Safety Record

The worst incident, in northern Vietnam's Phú Tho Province, killed 26 people and damaged an estimated 1,300 households in a 3-kilometer blast radius.

Last November, 11 female workers were killed and 17 injured in China as they assembled fuses for firecrackers. The factory was reduced to rubble.

This year has also started badly. In Australia, a 38-year-old man died from severe burns after a blaze broke out in a factory where fireworks were stored.

Pollution Problem

There's a similar gloomy environmental story facing fireworks. It has been known for a long time that fireworks are a cause of significant short-term, localized air pollution. During displays, all size ranges of atmospheric particles rise but the increase is particularly significant for fine particles of potentially toxic elements, such as Na, Mg, Al, Si, S, Cl, K, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Br, Rb, Sr, Ba, and Pb.

Many of these particles are small enough to be taken into the lungs and can cause breathing difficulties and aggravate lung disease. Studies have shown that firework displays at festivals like Diwali can increase air pollutants by nearly six times and the Lantern Festival in China by a similar level. Another study in Eastern Spain (mascletàs) has recorded increases of firework-generated fine-particle pollutants in excess of 100 times normal levels.

Authorities across the world are beginning to take a close look at the environmental effects of fireworks and take action — especially in fast-developing industrialized countries.

In China, over the recent Lunar New Year celebrations, "heavy air pollution" was recorded in 68 of the 161 cities monitored, while 16 experienced "severe air pollution." While not all of this is due to fireworks, many believe they are contributing to China's current chronic air pollution problems.

In Peru, fireworks were estimated to increase air pollution in the capital, Lima, by 24% over the maximum allowed limit during the Christmas holiday period.

In Manila, the Philippines, environment officials found that fireworks caused air pollution nearly 10 times above acceptable levels. The average reading was 1,437 µg/Ncm (micrograms per normal cubic meter of air). The World Health Organization's guidance for acceptable limits of air pollution is 150 µg/Ncm.

More Environmentally Friendly

So apart from limiting or banning fireworks, what can be done to lessen air pollution and reduce hazards? Both are challenging.

Changing the composition and types of chemicals in fireworks can help reduce pollution. China introduced more environmentally friendly fireworks this year, but reported sales were disappointing, illustrating the need to consider performance and pollution.

However, researchers are beginning to find new ways to reduce the environmental influence of fireworks without affecting their performance — especially the sound they make.

One of the solutions researchers are looking at is to reduce the particle size of the chemicals in the firework. Researchers have found that fireworks made from smaller nanoparticles require a reduced amount of chemicals to achieve the same performance. The result is less pollution.

Tests involving cake bombs or repeaters — one of the most popular fireworks after sparklers and firecrackers — made from nanoparticles required just a quarter of the powder used in traditionally made fireworks. Other tests, involving firecrackers, have resulted in sulfur dioxide emissions being reduced by 61%.

There are challenges to safety, though. When the particle size of metal powders is reduced, the risk of explosions increases. The smaller particle sizes increase the surface area and the rate at which they burn. Smaller particle sizes also increase the risk of dust clouds, making them easier to ignite.

However, researchers believe the risks can be reduced with further research and the development of safer production methods.

Lessons From History

While the potential for more environmentally friendly fireworks is a work-in-progress, safety in the fireworks industry must be addressed immediately.

Thousands of tons of fireworks are shipped around the world and stored safely each year. But experience has shown that a relatively small ignition source can escalate to a large explosion capable of damaging buildings over extensive distances, resulting in many fatalities and injuries.

It's an issue the Institution of Chemical Engineers (IChemE) has looked at several times over the past two decades as part of its process safety and loss prevention work.

Culemborg (1991), Ferrensby (1998), Enschede (2000), Carmel (2002) and Lewes (2006) are some of the incidents looked at in detail by IChemE.

There were clear lessons identified from these incidents with human failings one of the biggest contributing factors. IChemE's analysis found that the main causes of accidents were:

- Operators being unaware of, or choosing to ignore, the real hazards associated with the fireworks they were handling.
- Operators failing to comply, either knowingly or unknowingly, with the constraints placed on them by regulations.
- Operators failing to observe basic precautions, either consciously or subconsciously, that would have eliminated or mitigated the effects of the incident. These include:
  - ensuring that fireworks are only stored in the areas designated by the explosives license;
  - ensuring that stores are adequately spaced to reflect the quantity and hazard of the contents;
  - ensuring that, where multiple stores are used, the doors of one store do not directly face those of another;
  - complying with the explosive limit for the stores;
  - ensuring that where dismantling or modification/fusing of fireworks is allowed by the license, these activities are performed in a designated building. In the U.K., modification and dismantling of fireworks is legally regarded as manufacture and requires licensed premises and a designated production area;
  - ensuring that the quantities of fireworks present in buildings designated for dismantling or modification and fusing of fireworks are kept to a minimum.

Sadly, failing to learn or share the lessons from previous accidents, and a culture of "it won't happen to me," are likely to be the cause of some of the accidents in 2013. Change is needed in an industry that has a higher incidence of accidents than most.

An effective safety culture supported by training, robust supervision and strong management would go a long way toward improving safety and standards in an industry that brings so much pleasure to millions of people each year.

Dr. Alana Collis, technical policy lead, Institution of Chemical Engineers (IChemE), Rugby, United Kingdom

Contact:
Dr. Alana Collis, technical policy lead
Institution of Chemical Engineers (IChemE)
Rugby, United Kingdom
acollis@icheme.org
www.icheme.org

Info

The role of chemical engineers to improve safety and risk in the chemical and process industries is explored in IChemE's latest technical strategy, Chemical Engineering Matters.

Eastman to Acquire U.S. Laminating & Coatings Producer

U.S. chemical producer Eastman has entered a "definitive agreement" to acquire Commonwealth Laminating and Coating, an independent U.S. manufacturer and distributor of window films and other specialty films for automotive, architectural and protective applications. Commonwealth, which has production and master distribution facilities at Martinsville, Virginia, along with nine global sales distribution centers, reported annual sales of $100 million in 2013. A price tag for the acquisition expected to be completed in the second half of this year was not announced.

Eastman said the buy will extend its global offering of performance films for solar control window film and protective film applications. Leveraging Commonwealth's expertise will allow the chemical producer to gain efficiencies through better utilization of manufacturing assets while driving consumer adoption and use of window films generally, it added.

In February, the Eastman board approved the repurchase of up to $1 billion of the company's common stock. CFO Curt Espeland said the buyback and the quarterly cash dividend of $0.35 per share reflects the company's solid financial position, including its strong cash flow.

Eastman said the share repurchases will be made from time to time in either the open market or private transactions. The timing, volume and nature of the repurchases will be at the discretion of management, subject to market conditions and may be suspended or discontinued at any time. (dw) ■

Bayer Breaks Ground for New HDI Plant in Shanghai

Bayer MaterialScience (BMS) has broken ground on a new 50,000 t/y plant for coatings and adhesives precursor hexamethylene diisocyanate (HDI) at its complex in Shanghai, China.

The plant due for start-up in 2016 is being touted as one of the largest facilities of its kind in the world. Bayer already has one HDI plant in Shanghai, which was expanded in 2013 from its original annual capacity of 30,000 t/y.

Tony Van Osselaer, head of industrial operations at BMS, said locating the new plant at the integrated Shanghai site will allow the company to introduce a new manufacturing process that has a low environmental impact while also satisfying stringent safety requirements. The gas-phase technology requires substantially less energy and solvent than conventional processes, he said. (dw) ■

Arkema and Solvay Pursue Battery R&D Projects

France's Arkema and Belgium's Solvay have announced R&D projects aimed at improving sustainability and safety of lithium batteries used in particular by the automotive industry.

Arkema is teaming up with Canada's Institut de Recherche d'Hydro-Quebec (IREQ) to develop a new "highly safe" electrolyte from fluoride and non-fluoride salts produced by the French company. As part of the deal, Arkema has licensed its technology for the fluoride salts to IREQ, which will hold intellectual property rights. The goal of the research, the partners said, will be to find a new electrolyte suitable for use in lithium-ion and lithium-polymer battery technologies that can find application in the automotive industry.

In a European Commission-supported program, Solvay Specialty Polymers has launched the LIFE+ GLEE project, which it describes as a highly focused sustainability program that aims to use water instead of organic solvents in manufacturing rechargeable lithium ion (Li-ion) batteries. As cathode materials are usually water-sensitive, Solvay notes, most processes use organic solvents. Many of these, however, have been classified by the European Chemicals Agency - the body that administers REACh - as "substances of very high concern," with progressive substitution encouraged.

© viappy - Fotolia.com

Employing an innovative cathode protection technology that protects the active material from water contact during the manufacturing of cathodes, Solvay said it intends to develop a process that goes a step farther than most alternatives. The "unique technologies" that the company says will carry no toxic risks and also will reduce the manufacturing costs associated with solvent recovery and re-purification processes, will be tested in a pilot plant Solvay is building at Bollate, Italy. The facility is expected to start up in time for the Milano Expo 2015 being held from May 1 to Oct. 31 next year.

Solvay said sufficient quantities of the clean chemical material will be made available for evaluation by battery makers and research organizations. Additionally, batteries made with the material are to be made available for testing by independent groups and end-user consumers such as manufacturers of electric cars. (dw) ■

Events

Smart Fabrics & Wearable Technology 2014, 23 - 25 April 2014, San Francisco, USA
Over 250 of the world's top professionals in the smart fabrics and wearable technology industry will gather in San Francisco for three days of networking, hands-on experiences, and to listen to the latest content from a panel of renowned speakers. The event is targeted at anyone focused in smart fabrics, wearable technology, sensors, e-textiles, smart health products, body sensing technology, or flexible OLEDs among other topics.
► http://www.smartfabricsconference.com/

25th Annual Flame Retardancy Conference, 19 - 21 May 2014, Stamford, USA
Now in its 25th year, BCC Research's annual Conference on Recent Advances in Flame Retardancy of Polymeric Materials is the premier industry event of its kind in the United States. Geared specifically toward scientists and other technical specialists, this forum provides insight into recent innovation in the flame retardancy industry. Professionals from around the world will gather to attend informative sessions presented by industry experts from both government/academia and the commercial/industrial sectors. In addition to the main program, the conference is preceded on May 18 by an interactive "short course" for industry newcomers on the Selection, Evaluation, and Commercial Application of Flame Retardant Polymers.
► www.bccresearch.com/conference/flame

AFPM Reliability and Maintenance Conference, 20 - 23 May, 2014, San Antonio, USA
The 3-day program of the American Fuel and Petrochemical Manufacturers' (AFPM) Reliability and Maintenance Conference includes keynote addresses, technical and management presentations, discussion groups, structured question and answer sessions, and an exhibition of products and services. Presentations focus on improving reliability in the refining and petrochemical industry, covering topics such as effective maintenance organization, productivity, equipment reliability, health and safety, training, environmental control, predictive/preventive maintenance, maintenance and engineering standards, inspection, procurement, and innovative reliability technology. Amongst others, David Woods, Senior Manager at T.A. Cook, will be running a workshop entitled "Dynamic Turnaround Scheduling".
► www.afpm.org/conferences

FECC Annual Congress 2014, 26 – 28 May 2014, Rome, Italy
Over the years, the annual congress of the European Association of Chemical Distributors (FECC) has become recognized as the key event for the chemical distribution industry to get together and discuss the most current issues within the industry. The congress is also a key date in the European chemical industry's calendar as hundreds of delegates, from business leaders to stakeholders, attend every year. The 2014 sessions will focus on the distribution market, sales & marketing, software solutions & legislation for the distribution industry, understanding the advocacy process, and future trends. The sessions will be moderated by Günther Eberhard of Districonsult and Wolfgang Falter of Alix Partners.
► www.fecc-congress.com

Inachem 2014, 14 – 16 August 2014, Jakarta, Indonesia
Indonesia is at an economic turning point. Forecast to become the world's seventh largest economy by 2013, the Indonesia of today shows promise. Demand for chemicals is increasing driven by economic and industrial growth. Petrochemicals and Fertilizers are two major chemicals expected drive the growth during the forecast period. Growing demand for plastics is to create substantial demand for petrochemical products. Opportunities in the chemical industry exist in urea fertilizer, polypropylene, polyethylene, ethylene, decorative paint segments. Inachem 2014 will be the third dedicated event targeted to the region and serving the entire spectrum of the chemical industry covering chemical, petrochemical, processing and technology.
► www.ina-chem.com

European Adhesive & Sealant Conference and Expo 2014, 17 - 19 September 2014, Berlin, Germany
Organized by the Association of the European Adhesive & Sealant Industry (FEICA), the 2014 convention will include several focus areas such as adhesive & sealant market trends, resource efficient technologies, feedstock trends, next generation products and new product applications. Market drivers and trends will be discussed for areas like construction, civil engineering, electronics, medical, paper & packaging, footwear and leather. Experts will provide insights into developments in hot melts, solvent-based, water-based, pressure-sensitive and reactive adhesive systems as well as trends in polyurethanes, silicones, silane and other sealant systems.
► www.feica-conferences.com

Chemeca 2014, 28 September - 1 October 2014, Perth, Australia
Chemeca is an annual conference for the Australian and New Zealand community of chemical and process engineers and industrial chemists who come together to discuss latest developments in the field, recognize outstanding achievement and share lessons learned. The theme of this year's conference is "Processing Excellence; Powering Our Future". Chemeca is jointly hosted by the Royal Australian Chemical Institute (RACI), The Institution of Chemical Engineers (IchemE) in Australia and in New Zealand, Engineers Australia, and the Institution of Professional Engineers New Zealand (IPENZ).
► www.chemeca2014.com

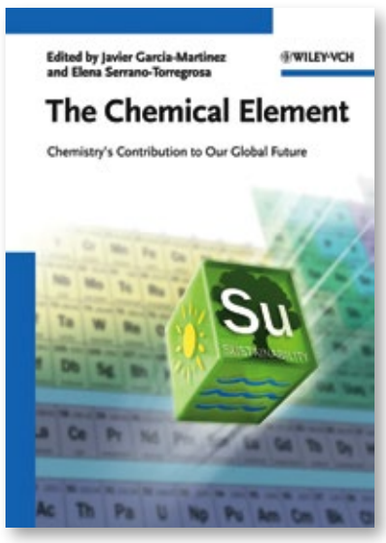
Valve World Expo 2014, 2 - 4 December 2014, Düsseldorf, Germany
The third Düsseldorf edition of Valve World Expo presents valves and fittings along with relevant components and parts, actuators and positioners, pumps, compressors, engineering services and software. Traditionally, European companies are represented in great numbers, but many exhibitors travel to Düsseldorf from overseas countries such as the USA, India, China, South Korea and Taiwan. Workshops on a variety of topics will be offered in addition to the lectures. Experts from around the globe will be on-hand to engage conference participants in an exchange on the innovations from the dynamically growing valve technology segment and related upstream and downstream technologies.
► www.valveworldexpo.com

Hydrogen and Syngas Production and Purification Technologies

This book discusses promising, more efficient directions in the energy industry fuel cells and hydrogen-based energy. This book covers the fundamentals of catalysis and proceeds to discuss applications in practical systems, including nuclear and gas power plants. Written by leading researchers and professionals, it is a practical reference for engineers working on fuel processing or fuel cell technologies in industry, NASA, and the military, as well as a great text for graduate courses in chemical engineering, mechanical engineering, and chemistry.

► Hydrogen and Syngas Production and Purification Technologies
Ke Liu, Chunshan Song, Velu Subramani
Wiley, Hoboken, USA
Price: € 94,60
ISBN 13: 978-0471719755

The Chemical Element: Chemistry's Contribution to Our Global Future



In the International Year of Chemistry 2011, prominent scientists highlight the major advances in the fight against the largest problems faced by humanity from the point of view of chemistry, showing how their science is essential to ensuring our long-term survival. Following the UN Millennium Development Goals, the authors examine the ten most critical areas, including energy, climate, food, water and health. All of them are opinion leaders in their fields, or high-ranking decision makers in national and international institutions. Intended to provide an intellectual basis for the future development of chemistry, this book is aimed at a wide readership including students, professionals, engineers, scientists, environmentalists and anyone interested in a more sustainable future.

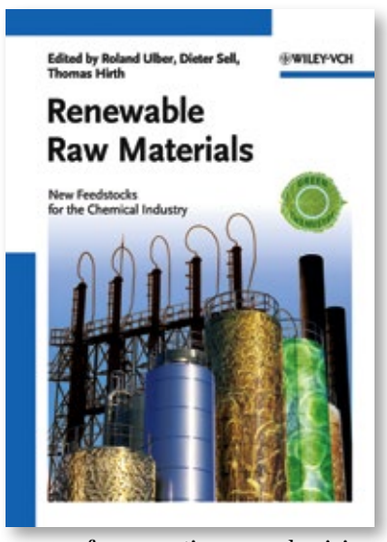
► The Chemical Element:
Chemistry's Contribution to Our Global Future
Javier Garcia-Martinez, Elena Serrano-Torregrosa
Wiley-VCH, Weinheim, Germany
Price: € 24,90
ISBN 13: 978-3527328802

Renewable Raw Materials: New Feedstocks for the Chemical Industry

One of the main challenges facing the chemical industry is the transition to sustainable operations. Industries are taking initiatives to reduce resource intensities or footprints, and by adopting safer materials and processes. Such efforts need to be supported by techniques that can quantify the broad economic and environmental implications of industrial operations, retrofit options and provide new design alternatives.

This contemporary overview focuses on cradle-to-grave life cycle assessments of existing or conceptual processes for producing value added fuels, chemicals, and/or materials from renewable agricultural residues, plant-derived starches and oils, lignocellulosic biomass, and plant-based industrial processing wastes.

It presents the key concepts, systems, and technologies, with an emphasis on new feedstocks for the chemical industry. Each chapter uses common themes of specific raw materials, thus forming a natural progression throughout the book. The result is coverage from a wide

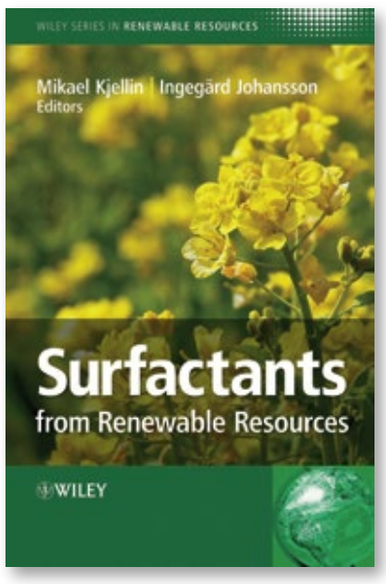


range of perspectives, emphasizing not only the technical issues but also considering the market place and socio-economic aspects.

► Renewable Raw Materials:
New Feedstocks for the Chemical Industry
Roland Ulber, Dieter Sell, Thomas Hirth
Wiley-VCH, Weinheim, Germany
Price: € 115,00
ISBN 13: 978-3527325481

Surfactants from Renewable Resources

Surfacants from Renewable Resources is a comprehensive text that meets scientists' demand for information on new biodegradable surfacants with safer properties for modern industrial formulations. This edited volume explores the current status of the research and applications of "green" surfactant chemistry. It provides an overview to the desired properties in different fields and focuses on bio-based products that have the potential to improve sustainability of natural resources and environmental quality. Aimed primarily at industrial researchers in companies producing surfacants, this book presents the arguments for green and sustainable materials.



► Surfactants from Renewable Resources
Mikael Kjellin (Publisher), Ingegärd Johansson
Wiley, Hoboken, USA
Price: € 118,34
ISBN 13: 978-0470760413

People

Amy Hebert

Amy Hebert has been appointed as vice president, Europe at Celanese. Hebert joins Celanese from Albemarle where she most recently led the catalyst business as vice president. During her time with Albemarle, Hebert held a variety of positions with increasing responsibilities. She also held an assignment in France and served as vice president of Albemarle's performance catalyst solutions division, which became one of the fastest-growing divisions under her leadership. In her new role at Celanese, Hebert will be accountable for profitably growing Celanese's businesses in Europe, optimizing manufacturing and maintaining cost competitiveness. Hebert earned her Bachelor of Science degree in Chemical Engineering from the Georgia Institute of Technology.

Meeta Gulyani

Meeta Gulyani has been named as Head of Strategy and Global Franchises at Merck Serono, effective May 7. Gulyani will lead Merck Serono's global franchises with a strong focus on defining integrated strategies for disease areas. Gulyani joins Merck Serono, the biopharmaceutical division of Germany's Merck, from Roche where she was most recently General Manager for South Asia and previously Vice President of Global Portfolio Management. Prior to joining Roche in 2010, she spent eight years at Sanofi. She holds an MBA from the Asian Institute of Management, Philippines, and a BA in Economics from the Shri Ram College of Commerce from the Delhi University, India.

Tim Hassinger will succeed Antonio Galindez in his position as president and CEO of Dow Agrosciences. Galindez will retire from the company effective May 1 after more than 31 years of service. Hassinger joined Dow in 1984, working in various sales, marketing and supply chain roles before being named global business leader in the Insecticides business unit in 2001. After serving as the regional commercial unit leader for Greater China, Hassinger became global leader for Europe, Latin America and Pacific. He assumed his current responsibilities as leader of the global Crop Protection business unit in 2009 and added global commercial leadership responsibilities last year.

Rob Buntinx

Rob Buntinx leads the new organizational unit Global Focus Industries and R&D at Styrolution. The global styrenics supplier has established the new unit with the aim to strengthen its customer-centric innovation and drive growth. A styrenics industry veteran who started his career at DSM in 1996, Buntinx joined BASF in 2000 and served as Director Business Management Copolymers from 2008 through 2011 when the styrenics business was carved out of BASF and merged into a 50:50 joint venture with Ineos. The formation of the new unit aligns with the Styrolution's growth strategy, which calls for three 'shifts' intended to put greater focus on three areas: higher-growth industries, ABS Standard and styrenic specialties, and emerging markets.

Andrew Sandford

Dr. Jennifer Mitcham

Andrew Sandford joins Catalent as Vice President Business Development, Biologics. Sandford previously served as the Vice President of Business Development for Selexis, where he established the U.S. subsidiary of the company. Prior to this, he worked with Dow Chemical's Ventures Business Unit; Dowpharma, and Cambrex Biopharma. A microbiologist by education, Sandford holds a BS from the New York State University. In a newly created role, Catalent has also appointed **Dr. Jennifer Mitcham** as Director, Business Development for Antibody-Drug Conjugates (ADC), Biologics. She joins Catalent from Theraclone Sciences where she was Senior Director, Program Management, responsible for the development of the lead clinical antibody therapeutic program. Prior to Theraclone, she was with Corixa Corporation. Mitcham holds both a BS in Biochemistry & Biophysics from Texas A&M University and a PhD in Molecular Genetics from the University of Colorado Boulder.

Ian Muir has been appointed to the newly created position of Commercial Managing Director at Aesica. Muir's responsibilities cross all three of the Pharma CDMO's service offerings in API manufacture, formulation development and formulated products and he will lead the expansion of the business into new growth markets such as China and Japan. Muir holds a Ph.D. in Pharmaceutical Science and has over 20 years' experience in the pharmaceutical industry. His most recent role was at Catalent where he was responsible for the global provision of contract development and manufacturing services for oral dose forms.

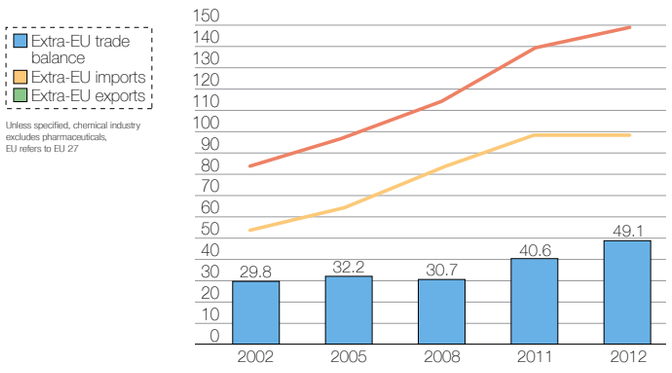
Baali Muganga has been appointed to the role of East Coast US Business Development Manager of Aesica. Central to her new role is responsibility for expanding the share of the company's east coast North American contract development and manufacturing market in pharmaceuticals. Muganga brings over five years new business experience gained across the life sciences industry. Recently, she worked at Reata Pharmaceuticals. Prior to this, she worked at AstraZeneca and the Children's Hospital of Philadelphia. She received a B.A. degree in Biological Basis of Behavior from the University of Pennsylvania.

Dr. Thomas Zimmer has been named to the newly-created position of Vice President of European Operations at ISPE, the International Society for Pharmaceutical Engineering. In this role, Zimmer is responsible for leading ISPE's business development and advancing strategic relationships in Europe. Zimmer is a licensed pharmacist. Prior to joining ISPE, he was Senior Vice President at Boehringer Ingelheim. He holds a PhD in Pharmaceutical Technology from the University of Frankfurt am Main, Germany. In addition to his professional experience, Dr. Zimmer has held numerous advisory posts within the pharmaceutical industry.

The EU Chemical Industry's International Trade Balance

Extra-EU chemicals trade balance

Extra-EU trade flows: Chemicals (€ billion)



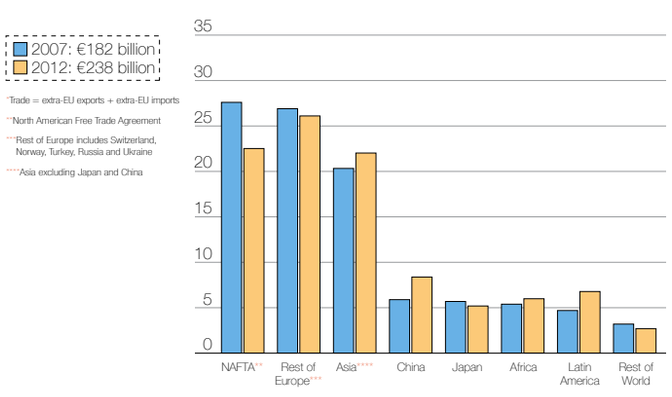
Source: Eurostat (Comext), CEFIC © CHEManager International

Top Ranking in Total Trade

The EU chemical industry still holds the world top ranking in total trade. As a historically important player in the global chemicals market, the EU chemical industry continues to benefit from trade opportunities. The industry registered more than simply a solid recovery in 2012 after the 2008 economic crisis. It posted a record extra-EU net trade surplus of €49.1 billion, according to CEFIC's latest Facts and Figures report that was published in February and provides the most up-to-date information about the EU chemicals sector with the newest full-year data (2012) available. EU exports to non-EU countries climbed to €143.7 billion in 2012, while EU imports were €94.6 billion.

Extra-EU chemicals trade* by region

% share



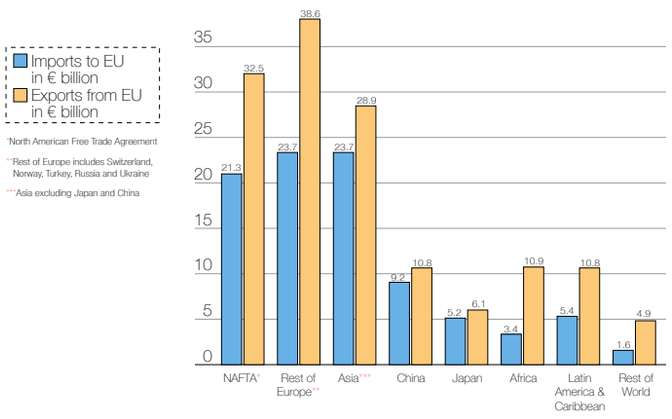
Source: Eurostat and Cefic Chemdata International (2013), CEFIC © CHEManager International

Trade with Emerging Markets

Extra-EU chemicals trade flow, calculated as total exports plus imports, in 2012 was mainly directed to the rest of Europe, with 26.2% of total trade flow going to the region. It was followed by the North American Free Trade Agreement (NAFTA) market with 22.6%. Asia, excluding Japan and China, accounted for 22.1% of EU trade flows. Taken together, the Rest of Europe – or non-EU-Europe – NAFTA and Asia markets contributed in 2012 to nearly 71% of total chemicals trade flows. Compared with 2007, the contribution to total trade activity from the rest of Europe, NAFTA and Japan declined, while the total contribution by China and the rest of Asia increased.

Extra-EU chemicals trade flows with major geographic bloc

EU trade surplus of €49.1 billion



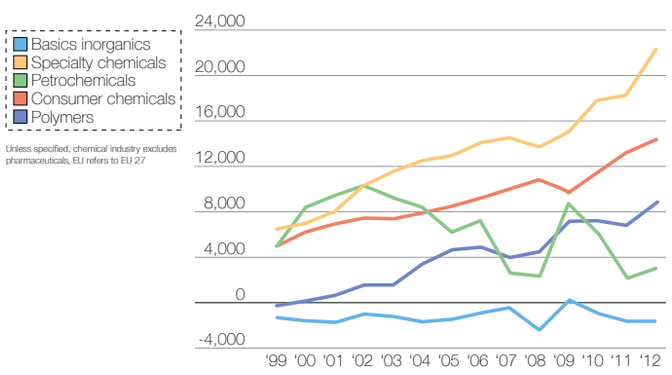
Source: Eurostat and Cefic Chemdata International (2013), CEFIC © CHEManager International

Deteriorating Competitiveness

The EU has a trade surplus with each of the main trading regions. However, the Trade Competitiveness Indicator (TCI), an indicator that compares the trade balance to total trade activity of a region reveals deteriorating competitiveness of the overall EU chemical industry. This means that total chemicals imports are growing faster than total chemicals exports. A look at the EU trade balance with a number of countries and regions shows that the EU's position is especially deteriorating with certain key performers among emerging Asian countries, with the Middle East and the U.S. for sectors such as base chemicals or petrochemicals.

Sectoral breakdown of EU chemicals trade surplus

Extra-EU chemical trade balance (€ million)



Source: Eurostat and Cefic Chemdata International (2013), CEFIC © CHEManager International

Trade Position of Sub-Sectors

Sectoral analysis shows that specialty chemicals and consumer chemicals performed well in 2012. The trade surplus in these sectors increased by 21.7% and 8.1% respectively in 2012 compared with 2011. Almost half of the EU chemicals trade surplus in 2012 (47.8%) came from specialty chemicals and 30.7% from the consumer chemicals subsector. Basic inorganics experienced a trade deficit of €1.8 billion – the only sector with a trade deficit since more than 10 years ago. But the trade position of certain sub-sectors such as raw materials and energy-intensive fields like petrochemicals and fertilizers shows signs of serious deterioration.

Safe Plasticisers for PVC Medical Devices

A report on PVC plasticizers presented recently by the Danish Environmental Protection Agency, the Danish Health and Medicines Authority and the PVC Information Council Denmark (a partner of the PVCMed Alliance) says that there are appropriate alternatives to classified phthalates like DEHP.

The study "Alternatives to classified phthalates in medical devices", which is based on the evaluation of ten existing PVC plasticizers concludes that most of the alternatives to DEHP that have been evaluated for their human health and environmental hazard profiles are considered to be appropriate alternatives.

However, "data are lacking for some of the alternatives, before a toxicological assessment can be carried out", says Shima Dobel from the Danish Environmental Protection Agency.

The PVCMed Alliance partners provided data on the plasticizers to the Danish authorities. "Many different plasticizers have been developed and are increasingly being used in a wide array of medical applications allowing medical professionals to benefit from PVC's unique properties for patient comfort, economic affordability and hospital hygiene. We encourage the value chain to commit to continuous improvement of safety in order to develop innovative products for all PVC healthcare applications", stresses Brigitte Dero, PVCMed Alliance representative.

Furthermore, the report outlines the need for certain types of medical devices to be "extremely soft and flexible" and "be able to offer the most efficient and qualitative treatment of patients". PVC-based healthcare applications have a fundamental role in ensuring this quality of healthcare thanks to PVC's technical properties including flexibility and resilience, softness, sterilizability, chemical stability, biocompatibility, clarity and transparency, durability and dependability, resistance to chemical stress cracking, low cost, and many others. ■

© Dario Lo Presti - Fotolia.com

New Cabs on the Block – Times have changed since 1976 when Robert De Niro used to be a night-time "Taxi Driver" in New York City! Since October 2013, the all-new Nissan NV200 taxis are taking passengers to Times Square and the city's other landmarks. In the new NYC taxi fleet the acrylic resin driver-passenger partition is replaced by plastic glazing made of polycarbonate (PC) which has high impact resistance, does not impair visibility and offers better fire safety features. The "Taxi of Tomorrow"-named product of a unique development collaboration, the new NV 200 Taxi which has been completely redesigned from powertrain, to chassis, to interior fit and finish reflects the input of hundreds of taxi owners and drivers, and thousands of passengers from all walks of life.

Coming Up in the May Issue of CHEManager International

- Challenges Facing the Pharmaceutical Industry: Can Pharma Restore its Broken Image? Interview with John LaMattina
- Addressing Today's VUCA Challenges: Lean Supply Chain Planning for the Pharma Industry by Dr. Josef Packowski and Michael Jarosch
- Essential Ingredients: Classification of Organic Chemicals for the Pharmaceutical Industry by Rolf Dach
- A Place to Thrive: Industrial Parks Benchmarking by Gunter Festel
- Catching Up: Implications of the Closing Wage Gap between the European and Chinese Chemical Industry by Kai Pflug
- China: Evolution of a Dynamic Market by Emily Kimball
- Refinery and Petrochemical Plant Chemicals by Sean Milmo
- Life-Cycle Assessment of Chemical Products by Günter Fleischer and Wulf-Peter Schmidt

And much more!

Imprint

Publisher:
Wiley-VCH Verlag
GmbH & Co. KGaA
GIT VERLAG
A Company of
John Wiley & Sons, Inc.

Geschäftsführer
Dr. Jon Walmsley,
Bijan Ghawami

Director
Roy Opie

Product Management
Dr. Michael Reubold (mr)
Tel.: +49 6201 606 745
michael.reubold@wiley.com

Editor-in-Chief
Brandi Schuster (bhs)
Tel.: +49 6201 606 755
brandi.schuster@wiley.com

Editor
Dr. Roy Fox (rf)
Tel.: +49 6201 606 714
roy.fox@wiley.com

Media Consultants
Corinna Matz-Grund
Tel.: +49 6201 606 735
corinna.matz-grund@wiley.com

Thorsten Kritzer
Tel.: +49 6201 606 730
thorsten.kritzer@wiley.com

Jan Kaeppler
Tel.: +49 6201 606 522
jan.kaeppler@wiley.com

Roland Thomé
Tel.: +49 6201 606 757
roland.thome@wiley.com

Marion Schulz
Tel.: +49 6201 606 565
marion.schulz@wiley.com

Team Assistants
Beate Zimmermann
Tel.: +49 6201 606 764
beate.zimmermann@wiley.com

Jörg Stenger
Tel.: +49 6201 606 742
joerg.stenger@wiley.com

Freelancers
Dr. Sonja Andres
Dede Williams (dw)
Miranda Kennedy
Dr. Volker Oestreich
Sean Milmo (sm)

Production Managers
Christiane Potthast
Claudia Vogel (Advertising)
Ramona Kreimes (Litho)

Reprints
Dr. Katja Habermüller
Tel.: +49 6201 606 719
katja-carola.habermueller@wiley.com

Subscription/Reader Service:
Silvia Amend
Fax: +49 6201 606 100
silvia.amend@wiley.com

Bank Account
Commerzbank AG Mannheim, Germany
Account No. 07 511 188 00,
Routing No. 670 800 50
BIC: DRESDEFF670
IBAN: DE94 6708 0050 0751 1188 00

The current price list is valid from 1st October 2013

CHEManager International appears 10 times in 2014.

Print run: 20,000
(IVW Report
Q4 2013: 19388 tvA)
Tenth year 2014
Subscriptions
10 issues €85.70
incl. postage
single copy €13.80
plus postage

Students receive a discount of 50% upon presentation of a valid certificate. Subscription orders can be canceled within 1 week in writing. Dispatch complaints are possible only within 4 weeks after publishing date. Subscription cancellations are accepted
6 weeks before end of year.

Original Articles
Specially identified contributions are the responsibility of the author. Manuscripts should be addressed to the editorial office. Instructions for authors may be requested from the publishing company. We assume no liability for unsolicited, submitted manuscripts. Reproduction, including excerpts, is permitted only with the permission of the editorial office and with citation of the source.The publishing company is granted the exclusive, space and content restricted right to arbitrarily use the unmodified work/editorial contribution for all purposes for itself and for businesses that have an interest in the publishing company as defined by company law as well as to transfer the right of use to third parties. This right of use applies to both print and electronic media including the internet and data banks/data media of all types.

Printed by
Druckzentrum Rhein-Main
GmbH & Co. KG
Alexander-Fleming-Ring 2
65248 Rüsselsheim, Germany

Printed in Germany
ISSN 1861-0404

GIT VERLAG
A Wiley Brand

Index