

# Innovation drives PU market growth

Demand for polyurethanes continues to grow at above average chemical industry rates as producers and processors focus on innovation, modifying the chemical properties of raw materials and improving the additives and processing technologies used

JOHN BAKER ICIS

**F**rom comfortable furniture and bedding to energy-efficient buildings and refrigerators; from long-lasting coatings and lightweight automotive components to high performance clothing, footwear and sports equipment, one polymer family stands out for its versatility in use – polyurethanes (PUs).

This versatility of application is driven by a high level of performance and an equally high level of innovation. Producers and processors are continually tailoring the material for specific end-uses and developing material properties, both to aid processing and boost performance.

The key lies in the nature of the PU chemistry. These polymers are the result of the reaction of an isocyanate – either methylene diisocyanate (MDI), toluene diisocyanate (TDI) or hexamethylene diisocyanate (HMDI) – with a polyol, usually a polyester or polyether polyol, to create a cross-linked thermoset resin, a thermoplastic resin or elastomer.

A huge range of properties can be engineered by tailoring the chemistry of these starter materials and the way they are combined. Further versatility derives from the fact that the PU can be either solid or foam – rigid or flexible – in form, depending on whether a blowing agent is used during the reaction process. Use of additives to impart flame retardancy or in combination with reinforcing materials such as glass fibres further expands the range of properties and applications for these versatile materials.

This performance and versatility is reflected in strong and growing demand from the marketplace. Consumption is growing by between 5-10% annually, depending on specific market segments, according to various producers and analysts.

Jon Penrice, global vice president for polyurethanes at The Dow Chemical Company, points to the fact that PUs' growth is generally



**Innovation in the laboratory: development of visco flex slab stock at Dow's Texas facility**

outpacing that of GDP by a factor of 1.7 times. "We see this as a result of PUs' ability to replace other materials in a wide range of applications – wood, metal, rubber, etc... but another major factor is growing demand in developing economies for products using PUs," says Penrice.

## HEALTHY MARKET GROWTH

He cites the growing middle class in countries like China and India, as well as Africa, who are buying more fridges, furniture and bedding, for example. The growth in car ownership in these developing economies is also driving PU demand. Government regulations in many developing and developed countries on energy efficiency are also stimulating the use of insulation, further boosting PU uptake.

Recent figures compiled by BCC Research estimate the global PU market should grow by 6.4% between 2016 and 2021, on a compound annual growth rate (CAGR) basis, and be worth \$68bn in 2021. Global consumption in 2015 was at 28.6m tonnes.

Furniture and bedding, the largest market sector, is expected to see 5.9% CAGR growth to \$24.6bn, while building and construction will advance by 7.4% to \$15.5bn.

BCC notes that "the market is expected to achieve significant demand growth in coming years". "Contributions from key players such as BASF, Covestro, Dow and Huntsman through innovative new technologies and applications will boost the polyurethanes market," it adds. It cites, for example, 3D printing, textiles and healthcare applications as areas ripe for PU to expand into.

Innovation at Dow is taking place across a wide front. The company divides PU into three broad areas: comfort, insulation and durable applications, bringing new developments to market across all three.

In the comfort area, for instance, Dow recently introduced a new mattress foam technology that promises a more comfortable sleep experience due to tailored cell structure in the foam.



The Dow Chemical Company

**Innovation in trainers: athletic shoe maker Xtep highlights Dow memory foam technology using an informative hang tag**

» Advances in the comfort area are also being made in the footwear industry, explains Penrice. Here Dow has developed the ENERLYTE™ system – a high rebound PU elastomer soon to be launched in Europe and North America. The novel material not only gives bounciness and springiness when walking, but is also very lightweight – an important trend in sport and leisure footwear today. ENERLYTE is designed for use in midsoles of casual shoes.

In China, Dow has worked with sports shoe maker X-tep to develop memory foam technology for sports insoles, reducing density and compression durability by 20% compared to ethylene vinyl acetate (EVA) and other PU foams, and allowing a lighter shoe to be made. Dow has agreed with X-tep to co-brand the innovation to the end-consumer, as part of Dow's drive to build-up its brand equity in the PU space.

In the insulation area, Dow is seeking to develop systems that can be produced with

**WILL KOONCE**  
R&D director, Dow Polyurethanes

**“Mattress microclimate and temperature regulation was always No 1 on the wish list”**

newer non-ozone and low global warming potential (GWP) blowing agents and is looking to develop halogen-free flame retardancy in these products.

**INNOVATIVE COLD CHAIN SOLUTION**

Another development underway in the insulation area is a collaboration with equipment maker Cannon of Italy on a novel fridge technology that includes both PU foam and assembly innovations. Known as PASCAL™ Technology, it claims to increase the energy efficiency of freezers and fridges without negatively affecting design or manufacturing productivity.

PASCAL is a two-component system that uses a vacuum process along with specially formulated PU foam to fill the insulating cavity of the appliance cabinet. The combination of PU formulation and vacuum system can fill the cabinet's cavity in less time than standard processes, enabling an effective and consistent cavity filling without using more material.

The system can yield 10% greater energy efficiency and cut fill time by 20-30 seconds, while also reducing demould time.

In the durable area, Dow is focusing on development of high-performance composites using a PU matrix and glass- or carbon-fibre reinforcement. This is still a relatively small,

but recently growing area, for the PU industry. Targeted application areas are the current domain of unsaturated polyester resin composites at the lower end of the performance range and epoxy resin composites at the higher end.

Says Dow's Penrice, “PUs are a good material for high-end performance, offering greater flexibility in high-end applications.” PU composites are characterised by their strength and durability and the fact that they can be produced using a number of technologies.

One of the drivers here, adds Andre Argenton, global R&D director of Performance Materials and Chemicals at Dow, is light-weighting, which feeds back directly to the quest for energy efficiency in many potential applications in, say, automotive and aerospace. “Use of PUs in composites is critical – we are growing a lot here, using new and traditional chemistries.”

**JON PENRICE**  
Global vice president, polyurethanes, Dow

**“PUs are a good material for high-end performance, offering greater flexibility in high-end applications”**



One key area, says Will Koonce, R&D director at Dow Polyurethanes, is to develop new chemistries to give control over the processing window during composite manufacturing. In pultrusion, for instance, Koonce adds, “You need to slow down the reaction, but still get the desired mechanical properties in the final part.”

**PULTRUSION FOR WIND POWER USE**

As one example, Penrice points to a recent pultrusion application in the manufacture of wind turbine blades, using a PU matrix and long-carbon-fibre reinforcements. Dow, through its DowAksa carbon fibre joint venture with Turkey's Aksa Akrilik Kimya Sanayii, has signed a deal with Vestas Wind Systems to produce laminates for carbon fibre spar caps using advanced process technology that assures the strength, stiffness and lighter weight needed.

DowAksa expects to provide more than \$300m worth of parts for carbon fibre-pultruded spar caps over the projected four-year contract. The parts will be manufactured at the DowAksa production facility in Yalova, Turkey.

While automotive applications for composites are of interest in the longer term, explains Koonce, in the more immediate term Dow is targeting more conventional composite applications in construction, such as window lintels, manhole covers pallets and telegraph poles.

“There is a wide assortment of applications where the toughness and durability of PU can find a place in the market, and where strength-to-weight ratio is important,” he adds.

**COMFORT SCIENCE**

**VORAZzz MEETS COMFORT REQUESTS**

MEMORY FOAM has become a popular choice for bedding since its introduction in the early 1990s. However, despite its attractive physical properties in terms of support, touch and feel, many customers report “sleeping hot” and feeling too warm when sleeping on it.

“It was a message we kept hearing from discussions with bedding OEMs and retailers,” says Dow's Will Koonce, R&D director at Dow Polyurethanes. “Mattress microclimate and temperature regulation was always No 1 on the wish list.”

This customer feedback led Dow's research team to investigate why this was the case and what could be done about it. It investigated how the foam material interacted with the body

in terms of heat dissipation and, using computer modelling, worked out what the foam structure needed to look like to give improved heat dissipation.

Then, says Koonce, the company went back to develop the chemistry to deliver this. The result was that within just two years, Dow came through with a new technology that addressed customers' needs. It is now marketing this to bedding OEMs in North America as VORAZzz™, and is exploring opportunities in other regions.

Conventional viscoelastic memory foams have closed cell structure that traps heat and moisture from the sleeper's body, creating an uncomfortable sleep environment. Dow's breakthrough was to

engineer a more open cell structure using customised polyols and new additives. “We designed these to make extremely porous foams, with an open a structure as possible,” says Koonce.

This enables increased air flows in the mattress and enhances wicking, so that heat and moisture are carried away from the body more quickly than in traditional foam mattresses. The result is a cooler, and thus better quality, sleep.

PU mattresses are a fast-growing segment of the bedding industry, with about one-third of all mattresses sold in North America made from foam or a foam/spring hybrid. And sales are growing twice as fast as traditional mattresses. ■



Global challenges: transport and urbanisation present opportunities for polyurethanes

# Stepping up to meet global challenges

Polyurethanes can help meet many of society's global challenges; the materials themselves are becoming greener as producers follow their sustainability agendas

**JOHN BAKER, ICIS**

**G**lobal warming and climate change, rapid urbanisation, mobility of people and goods, energy, water and food security... the list of major global social concerns is significant and growing.

Governments and regulators are responding to pressure from the public, NGOs and many savvy corporations with a raft of initiatives, covering, for example, carbon emissions, automotive fuel efficiency and building regulations. The UN's Sustainable Development Goals set far-reaching targets in many areas.

The chemical industry, commonly viewed as one of the key concerns in this area, is perhaps ironically the best chance society has for sustainable development. It is, after all, chemistry that makes the world go around. Leaders in the industry have adopted a highly collaborative position, and are working up and down their value chains to invent and implement sustainable solutions.

It is engaging with this from an internal perspective in terms of reducing its own carbon, water and waste footprint, and from an external one as it seeks to develop products that are safer and more sustainable – for

example by incorporating biobased materials, finding alternatives to potentially hazardous ingredients, and looking at the full life cycles of the products it enables.

The polyurethanes industry is well placed to play an important role in all of this. In the area of energy efficiency, it has well-developed solutions in construction and cold chain insulation. It contributes to the automotive industry's drive to lighter weight to improve fuel efficiency. In the urban environment, it offers high performance protective coatings that increase service life of utilities and infrastructure, which in turn reduces material consumption.

These solutions are gaining increasing recognition. Late in 2016, for instance, insulation materials from Dow Chemical were recommended for use in projects in China supported by the US-China Building Efficiency and Green Development Fund. This is a public- »

» private partnership convened by the Paulson Institute to provide financing to bring innovative technologies to China to reduce building energy emissions.

Two cities in China have signed up to progress construction projects in which recognised innovations will be utilised. These include Dow's spray foam for thermal insulation on exterior and interior walls and roofs; flex-faced insulation board for residential home insulation;

## MARCELO FISZNER

Marketing director polyurethanes, Latin America, Dow

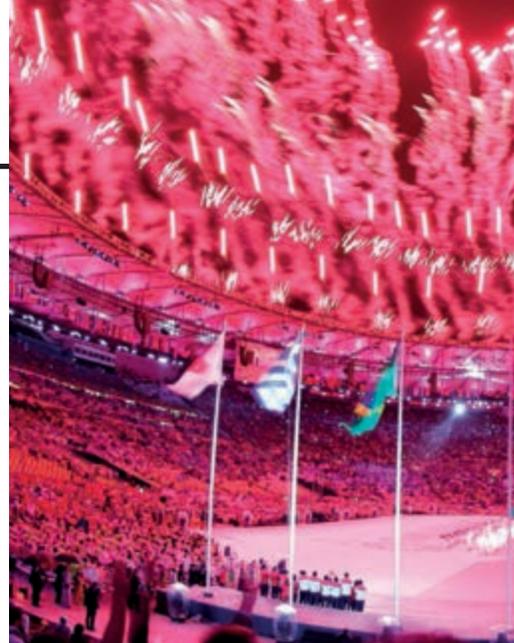
**"The most sustainable energy is the energy not used. The best approach is thus through insulation"**

metal panel rigid-faced insulation boards for cold storage facilities and industrial buildings; and pipe insulation for district heating and cooling and oil & gas applications.

Dow's engagement with the Fund is aligned to its "Leading the Blueprint" 2025 Sustainability Goal – a pledge to collaborate with stakeholders at all levels to facilitate the transition to a sustainable planet and society.

As China accounts for approximately 50% of all new construction in the world for the foreseeable future, Dow says it is working alongside governments and US and Chinese companies to ensure that sustainability is considered at the design phase of building development.

Promotion of thermal insulation in construction in Latin America has also been



addressed by Dow through its sponsorship of the 2016 Olympic Games in Rio de Janeiro. It also used this to help accelerate the phase-out in the region of foam blowing agents with high global warming potential (GWP) chemicals, promoting water or pentane blowing technologies instead (see story below right).

On the issue of urbanisation and transport, the Chinese adoption of bicycle-sharing has offered polyurethane makers an opportunity to take part in a development that reduced car transport – and hence carbon emissions – and improves the health of commuters. Polyurethanes also make rental bicycles more durable, lightweight and comfortable (see story left).

## MATERIALS SUSTAINABILITY

While polyurethanes help sustainability by providing solutions to global challenges, the industry is also seeking to make its products inherently more sustainable.

This is being driven forward on a number of fronts, from process innovation to make the manufacture of isocyanates and polyols more energy and resource efficient, to wider use of biobased and renewable intermediates, to the elimination of halogenated flame retardants and the move away from blowing agents of high GWP.

Biobased materials are gaining increasing interest and use in polyurethanes, notably on the polyols side of the formulation. Several companies are developing and introducing polyols that incorporate waste carbon dioxide as a raw material – notably Covestro and now Saudi Aramco through its acquisition of *Converge* technology from Novomer.

Biobased polyols can be derived from natural oil polyols (NOPs). Polyether polyols can be made from biobased diols, such as 1,4-butanediol (BDO), 1,3-propanediol (PDO), 1,2-propanediol and monoethylene glycol (MEG); polyether polyols can be based on sugars such as sorbitol, sucrose and glycerol; and polyester polyols can be made from diacids such as succinic acid, adi-

## DURABLE SCIENCE

# MOBIKE LOOKS TO PU FOR TYRE RESILIENCE

CHINA'S BOOM in bicycle-sharing services is spurring investments in tyre innovation among chemical producers. The number of "intelligent" bicycles available for sharing in China has surged to more than 30m in just two years, and is still growing.

The trend has caught the attention of the likes of Dow Chemical, BASF and Sinopec, all of which are bent on developing new applications to make the tyres of these bikes lighter, safer and more durable. They are turning to polyurethanes and thermoplastic elastomers to replace conventional sponge rubber tyres.

In May this year, Dow Chemical and China's Mobike, a leading shared-bicycle service provider, signed a strategic partnership agreement that will see the two companies collaborate at both the product development and marketing levels, leveraging Dow's diversified technology platforms and innovative materials and Mobike's leading position in China's bicycle-sharing market.

Under the terms of the agreement, Dow will deliver more innovative and integrated products, materials and



**China's Mobike and Dow are working together to improve the comfort and durability of shared bicycles**

solutions to Mobike, with the aim of developing lighter weight and more eco-friendly Mobikes that will consistently provide an enhanced riding experience and environmental benefits.

On "Earth Day" this year – 22 April – Mobike introduced its latest smart bicycle, the "Light Breeze," which uses Dow's innovative PU materials for its insert tyres. Compared with the traditional solid rubber tyre, the Dow PU insert tyre helps reduce weight by 20%, while improving shock absorption and durability.

Dow has now developed an all-polyurethane foam tyre for Mobike to give better shock

absorption and ride comfort.

In addition to PU materials, Dow will further partner with Mobike on R&D programmes and provide Mobike with more tailor-made innovative products and solutions in the future to further reduce the weight of the bicycle frame and other parts.

Fei Chen, Greater China sales manager for Dow Chemical China, says Dow approached Mobike last year as part of its drive to build relationships down the PU value chain. Its materials are used in bicycle saddles and tyres and uses in other areas are now under development with Mobike and the bicycle OEMs.

"As a global supplier, Dow will also support Mobike as it rolls out its bicycle-sharing concept around the globe," says Chen. Mobike is now active in the UK, Singapore, Japan and Italy. ■

## FEI CHEN

Sales manager, Greater China, Dow Chemical China

**"As a global supplier, Dow will support Mobike as it rolls out its bicycle-sharing concept around the world"**



XINHUA/REX/Shutterstock

### The Rio de Janeiro Olympics Game took deliberate steps to reduce its carbon footprint, with PUs playing a key role

pic acid, azelaic acid and even long chain diacids such as octadecanedioic acid (ODDA).

These polyols are specifically suited for their application in polyurethanes and have biobased content ranging from 15% to 70%, depending largely on the type of biobased feedstock employed.

Dow is active in these developments in some areas. In Brazil, for instance, its polyols are made from propylene oxide that is 40-50%

#### MARCEL MOELLER

Marketing director, EMEA and India, Dow Polyurethanes

### “We are developing the chemical process to break down polyurethane foam into components for reuse in classical PU applications”

renewable, derived from biomass, notably eucalyptus. This gives its polyols a 30-40% renewable content, says Marcelo Fiszner, Dow’s marketing director for polyurethanes in Latin America, giving the final polyurethanes around 20% renewable content.

“We use this as a selling point,” he notes, “It is a useful marketing tool as part of the portfolio. But it is unique to Brazil [in Dow’s PO production].”

Commenting on the industry move to use more renewables, Dow’s R&D director for polyurethanes Will Koonce, notes that Dow is engaged in this area and listening to what the market needs. “Sustainability is very critical in our products. But requests from customers and the market tend to be in terms of value propositions combining biobased needs with other features, to provide economic and performance benefits as well as environmental ones.”

He stresses that the quest for sustainability at Dow is not just seen in terms of product content but encompasses energy efficiency,

lightweighting, durability and so on. “When we find a solution where we can bring performance and economic benefits to the application, we will do so. In the end, performance and cost are key.”

#### MATTRESS RECYCLING

Marcel Moeller, marketing director EMEA, India for Dow Polyurethanes, says that recycling is also a key part of Dow’s sustainability thinking. In Europe, for example, where the concept of the Circular Economy is being driven by the EU Commission, Dow is looking at mattress recycling as a way of minimising the amount of material sent to landfills. This will become more urgent as 2020 approaches, when EU rules to reduce waste landfill come into effect.

It is currently working on an initiative with partners in Europe to develop a solution based around foam mattress collection and the chemical recycling of the polyurethane material, so that the recovered materials can be put into reuse.

“Together with partners, we are developing the chemical process to break down polyurethane foam into components for reuse in classical PU applications,” he adds. “But next to the chemistry complexity, a real challenge is a logistical one. Mattresses are large and bulky. You can’t ship them too far for recycling due to high transportation cost and CO<sub>2</sub> emissions. So it’s a local issue, requiring local solutions.” ■

#### INSULATION SCIENCE

### DOW’S OLYMPIC SPONSORSHIP AIDS ENERGY SUSTAINABILITY

THE OLYMPIC Games – arguably the world’s largest sporting event – give polyurethanes a chance to perform in public every four years. From sports surfaces to hockey balls and footballs; from swimwear to the bedding in the athletes’ accommodation, the versatile materials find extensive use.

As a Worldwide Partner of the Olympic Games, The Dow Chemical Company was involved in more than 20 projects connected to the Rio games in 2016. But over and above the obvious involvement in sports goods, the partnership offers Dow even more – a chance to drive forward the sustainability agenda on a wider front.

Polyurethanes are not only used widely in stadium and facility construction – for example in flooring applications and waterproofing systems – but also in PU foam-filled insulation panels, use of which cuts energy losses and helped reduce the carbon footprint of the games.

As part of its overall Olympic Partnership, explains Marcelo Fiszner, Dow’s polyurethanes marketing director for Latin America, Dow was also the Official Carbon Partner of Rio 2016.

As such, it worked to mitigate the carbon footprint of the Rio Games across major segments of the Brazilian economy. Dow used the games “as a catalyst to implement energy-efficient and low-carbon technologies across food production, industry and infrastructure.”

Fiszner says initiatives were designed to help offset 4m tonnes of emissions as a result of organising and running the Rio 2016 Games. Dow’s goal and its forecast is to mitigate 2m tonnes of emissions from non-transport activities, of which polyurethanes are responsible for achieving 1.2m tonnes.

Giving more detail, Fiszner points to two initiatives through which Dow achieved reductions. One was a project to accelerate the conversion



#### Dow’s Olympic sponsorship was used to promote energy efficient PU/metal cladding

in PU foam blowing from HCFC 141b to water or pentane blowing agents in Latin America. HCFC 141b is a very strong global warming agent, so switching more quickly than usual to the lesser polluting blowing agents was a key factor in cutting CO<sub>2</sub> equivalent emissions.

A second project was to help promote the use of PU insulating panels across Latin America in construction projects. Dow organised seminars in several countries to

promote the use of these energy-efficient materials to players along the value chain.

“We held eight seminars across the region, with 200 people attending each one – from government agencies, users and customers.” In Brazil, he explains, the four key insulating panel producers participated, with Dow making a short presentation to kick off the seminar. The energy-saving benefits of this PU panel technology for construction purposes were put on display and considered.

“The four panel producers – normally competitors – worked together to evaluate the performance, economic and environmental impacts of this type of insulation, so there was a unique open debate with the construction sector.”

As Fiszner says, “The most sustainable energy is the energy not used. The best approach is thus through insulation technologies and rigid polyurethane foams have proven to be the best insulating material.” ■

# Customer intimacy

Innovation is key to growth in the PU market, but translating customer needs into new products presents considerable challenges in terms of management and communication



The Dow Chemical Company

**Innovation is tailored to customer needs and delivered through a global R&D network**

## JOHN BAKER ICIS

The sheer breadth and depth of applications in the polyurethanes (PUs) industry and the ability to tailor material properties give plenty of scope for innovation. However, at the same time they make managing that innovation a challenging prospect.

Closeness to the customer is an all-important requisite – be that customer a processor of PUs, a brand owner or retailer, or an end customer. It is from these players that ideas, trends and requirements make their way back along the value chain to the PU scientists.

And it is here that these ideas and needs are translated into new materials, new properties and new products. In some instances, this can be done on a local level through customer service centres; in others it may take the

## WILL KOONCE

R&D director, polyurethanes, Dow

**“We make hundreds of different polyols and isocyanates and thousands of systems. We need processes to be efficient and flexible”**

resources of the central research and innovation function.

To address the challenge, Dow operates a global network of local and regional technical services and development (TS&D) centres and several innovation centres around the globe.

These are backed up by core R&D centres in various locations in the US, EU and Asia, and corporate process R&D and discovery R&D facilities. The core R&D labs are still close to the customer in the regions and focus on fundamental capabilities; they are intended to generate value for the businesses.

As Andre Argenton, global R&D director at Dow Performance Materials and Chemicals, explains, Dow’s innovation effort is structured to focus on the customer and the marketplace. It has innovation leaders in each of its four main geographies – the EU, the US, Latin America and Asia – to ensure that efforts are coordinated across the local and global scale.

“The magic is to ensure the innovation organisation is focused on ‘business relevant’ ventures, approved for value by the marketing organisation. If these are decoupled you can run the risk of missing value,” says Argenton.

He insists that time spent with the customer is critical. “The innovation function

must have a seat at the design table of the customer... and must ensure that information flows back to where it needs to go,” be that discovery, process or core R&D, or the local TS&Ds.

What do customers want? It’s a challenging question, says Argenton, given that PUs are so flexible and versatile as a result of the underlying chemistry. The driving forces in different end-use sectors vary by industry.

In furniture and bedding, it’s largely about comfort and how improvements in foam technology can drive value for the customer and the user.

In the energy sector, it is all about thermal insulation and product performance at affordable cost, he notes. In some geographies, environmental factors are driving innovation – looking for superior insulation values and flame retardancy – in others, cost is critical.

In the durables area, he adds that “each industry has its own unmet needs. It may be environmental performance, or light-weighting of components, there are many drivers...”

Will Koonce, R&D director, polyurethanes at Dow, adds that there are a number of main areas of focus at present. One is to improve the key basic functionalities of PUs, such as

## ANDRE ARGENTON

Global R&D director, Performance Materials and Chemicals, Dow

**“The magic is to ensure the innovation organisation is focused on ‘business relevant’ ventures, approved for value by the marketing organisation”**

making insulation more efficient, improving polymer processing and structural properties, and introducing new blowing agent and flame retardancy technologies.

The other is to improve the production processes Dow uses. Koonce says there are two big themes here: how can we make our processes and plants more efficient in terms of energy, waste and capital intensity; and how can we make our plants and processes more flexible?

“We make hundreds of different polyols and isocyanates and thousands of systems. We need processes to be efficient and flexible,” says Koonce. ■

# Consistent growth drives investment

Polyurethane markets are driving significant growth in isocyanates and polyols demand, stimulating investment in new capacity around the globe

ROB PEACOCK AND JOHN BAKER ICIS

The polyurethane (PU) market has been one of the faster growing segments of petrochemicals over the past decade. The global financial crisis in 2008 caused a brief pause in this growth, but since then the markets for the two main isocyanates, MDI and TDI, along with both polyether and polyester polyols, have typically been growing well above GDP growth rates.

This growth can be attributed to numerous factors, as PUs are used in a wide variety of end use sectors, from construction, transport, white goods and furniture, and in a variety of forms – rigid foams, flexible foams and elastomers, as well as adhesives, coatings and binders.

Within many sectors, the use of PUs has been growing faster than alternative and competing products, or has been used in rapidly developing new sectors and markets.

MDI (as polymeric MDI – PMDI) is principally used in rigid foam. This, in turn, is mainly used for insulation – either in the construction industry or in the production of refrigerators and freezers. These sectors have driven increased demand and usage levels globally, growing strongly even in developed markets in the US and Europe.

Pure MDI (MMDI) is used in a wide variety



Car manufacture in China is driving polyurethane investment in Asia

of formulations. Elastomers are one of the main products, with useful performance properties in diverse applications, from shoe soles and artificial leather to moulded components used in engineering and automotive applications. Again, many of these applications have seen robust growth.

As such, MDI has demonstrated the highest growth of the two main isocyanates, averaging around 6%/year since 2010. This strong global growth is expected to continue, at least in the short- to mid-term. Globally, ICIS forecasts that MDI demand will expand at an average of over 4%/year, over the next five years.

TDI is mainly used in the production of flexible PU foams, which typically go into mattresses and upholstered furniture production. Transportation seating is an important sub-segment. These applications have been experiencing slower growth than MDI applications.

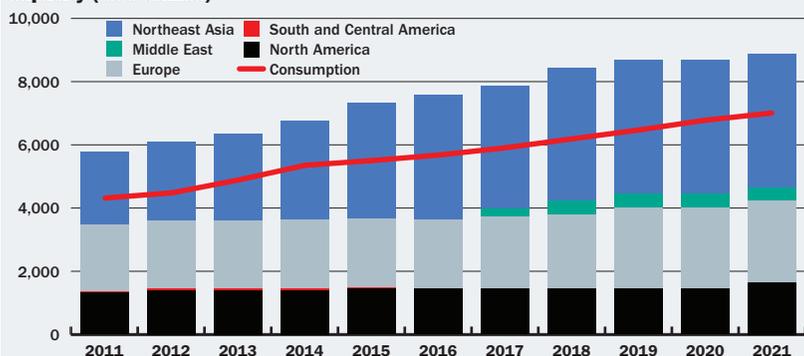
However, continued growth is expected in most developing markets, and increased supply to these markets should stimulate consumption and ICIS forecasts growth will remain at an average 3%/year in the next few years.

Polyether polyols are a family of products used in combination with isocyanates in PU manufacture. As such, growth rates are an indication of overall growth in the use of PUs.

Growth in demand for PUs, especially in the growth engine of China, has fostered continual investment in capacity over the past decade. »

## MDI CAPACITY BY REGION AND GLOBAL CONSUMPTION TREND

Capacity ('000 tonnes)



SOURCE: ICIS Consulting

## MIDDLE EAST

## SADARA START-UP ADDS PU CAPABILITY IN THE GCC REGION

JUNE AND July this year witnessed the start-up of PMDI and polyether polyols capacity in Jubail, Saudi Arabia – the first time these PU intermediates have been produced in the country and indeed in the GCC region as a whole.

Start-up of an associated TDI unit followed in August, marking a return to TDI production for Dow, following closures of units in Freeport, Texas, and Camacari, Brazil in 2010-11.

The plants form part of the giant \$20bn Sadara Chemical complex, developed by a joint venture between Saudi Aramco and Dow and consisting of no fewer than 26 chemical units. Chlorine, nitric acid, benzene, toluene, formaldehyde, aniline and propylene oxide will all be produced on the complex to feed the isocyanates and polyol units.

Plans by SABIC and Shell Chemicals to develop PU capability in Saudi Arabia have not been pursued since the companies said they

would not proceed with the planned propylene/oxide polyols part of the venture in October 2014.

The 400,000 tonnes/year PDMI facility is the largest single-train unit of its type in the world, with TDI capacity at 200,000 tonnes/year. Some 400,000 tonnes/year of polyether polyols will be produced in two trains, using propylene oxide and ethylene oxide, to produce multiple grades of product.

These materials will open up a completely new value chain in the GCC region and meet significant growth potential in the Middle East and Asia, says Sadara. Output will be marketed in the GCC region by Sadara, with Dow taking responsibility for other global markets.

Commenting on the first availability of commercial quantities of on-spec PMDI, Sadara CEO Ziad A-Habban noted, "The start-up puts Saudi Arabia firmly on the world map of major PU producers. This is indeed a significant milestone for Sadara."



Sadara's PMDI facility in Jubail is a first for the Middle East

He added that the polyols facility "will enable manufacturers in Saudi Arabia to obtain the speciality chemicals needed for a broad spectrum of applications... This will help create new industries domestically as well as generate enormous job opportunities for the Kingdom's young professionals."

The investment in PUs at the site has already attracted downstream interest. EA Juffali & Brothers is investing on the associated 12sq km

PlasChem Park and will build several manufacturing plants there. It has signed an MDI offtake agreement with Sadara and will use the material to cater to local demand for PUs in industries such as construction, furniture, special flooring for sports facilities and electrical appliances.

Sadara was announced in July 2011 and the first plants brought onstream in late 2015 (polyethylene) and mid-2016 – the naphtha/mixed-feed ethylene cracker. ■

» The global financial crisis put many planned investments on hold, but since 2009 around 2.6m tonnes/year of MDI capacity has been added, mostly at new units, but also as expansions at existing plants. Of this, almost 2m tonnes/year has been added in China.

Potentially the most game-changing will be the start-up this year of units at the Sadara Chemical complex in Saudi Arabia (see above). The start-up last year of a smaller (40,000 tonnes/year) MDI unit at Karoon in Iran could also impact supply and demand in the region.

The large-scale capacity expansions in China have caused some periods of oversupply in the Asian markets and have led to some rationalisation of older units. The Sadara MDI unit has been widely expected to have an impact not just on the Middle East, but on the global market.

However, with a number of production issues in the past year, the global market for MDI has become very tight, and the new unit could help provide some much needed liquidity to the global market. That said, with the high expected growth rates for MDI, the time frame for the additional material to be absorbed by the global market is not expected to be lengthy.

TDI is not forecast to grow as fast as MDI, but as the global market has also become tight in the past year, this smaller additional capacity will give customers in the Middle East and Africa a much-needed source of incremental product.

The polyether polyol market is not as subject

to outages or oversupply, as production is less concentrated. Still, the advent of a large scale integrated polyols facility in the Middle East will alter existing trade flows and give Sadara an important position in the global market.

#### NEW START-UPS ADD TO SUPPLY

In Europe, Covestro started up a new 300,000 tonne/year TDI unit in Dormagen, Germany, at the end of 2014, after a total investment of €400m. BASF has also recently expanded its TDI capacity in Europe, with a €1bn investment at Ludwigshafen that came onstream in the second half of 2015. The 300,000 tonne/year plant is said to be the largest single-train TDI unit in the world, but has been out of action since late 2016 due to technical problems. Full output is not expected to resume until 2018.

On the MDI front, Covestro is doubling its MDI capacity at Brunsbüttel in Germany to around 400,000 tonnes/year by the end of 2018. Citing firm demand, the company has decided to continue production of MDI in Tarragona, Spain, for the time being, after previously announcing it would shut the 170,000 tonne/year unit at the end of 2017. BASF, this year, has also boosted MDI capacity in Antwerp by 90,000 tonnes/year to 650,000 tonnes/year.

Additionally, EuroChem and ChemChina have just signed an MoU to develop Russia's first PU complex and are currently evaluating

the technical feasibility of the project. They are looking specifically at propylene oxide, propylene glycol, polyols, MDI and TDI.

If it proceeds, the project will be implemented at EuroChem's Novomoskovskiy Azot plant in the Tula region of Russia. ChemChina will deliver the necessary production technology.

In the US, MDI capacity is also seeing investment interest as market demand grows. Huntsman is adding 400,000 tonnes/year of new capacity at its Geismar, Louisiana, site, which is expected to be onstream in 2018. BASF is also boosting MDI in Geismar, taking capacity from 300,000 tonnes/year to 600,000 tonnes/year in stages.

More recently, China's Wanhua Chemical, the largest MDI producer by nameplate capacity globally, announced plans to build a new MDI plant in Louisiana, investing some \$1.12bn in the new plant.

The position in China is less positive with several projects on hold at present. However, the Huntsman/BASF joint venture MDI expansion with local partners in Caojing is expected to start up at the end of this year, adding 240,000 tonnes/year of capacity. This will double the existing output at Shanghai Lianheng Isocyanate Co (SLIC), established by the same partners in 2006. Chinese major Wanhua is currently adding 300,000 tonnes/year of TDI capacity in Shangdong, expected to be complete in the second half of 2018. ■