

# Advanced manufacturing comes to the fore in Singapore

Jurong Island.

## A focus on technology and innovation benefits from a global transport network

**A**sia is expected to account for 60% of global trade flows by 2020, shifting the focus away from Europe and North America. Strategically astride key trade routes at the heart of Asia, Singapore will further cement its position as a global trading hub for chemicals.

Far from passively gaining from this bounty, Singapore has demonstrated a deep and lasting interest in manufacturing with an eagerness to adopt new technologies in advanced manufacturing. Examples range from global majors such as Shell to specialty chemical makers like Chevron Oronite, Evonik and Denka, and worldwide logistics firms such as Vopak. They are investing billions not just in capacity, but in advanced technology for smart plants, radio-tagging of personnel for safety, and drone inspections.

Proactive investment allowances and favorable trade incentives will continue to entice companies to invest in Singapore. The nation's commitment to the future of manufacturing technologies and push for public-private partnerships is already spurring the adoption of advanced technologies in factories for improved competitiveness.

Singapore's workforce has attracted more chemicals majors to set up

research labs in Singapore. The Global Innovation Index 2016 ranked Singapore as most innovative nation in Asia and sixth most innovative globally. There is ready talent to take on jobs in advanced manufacturing that are innovation and knowledge intensive

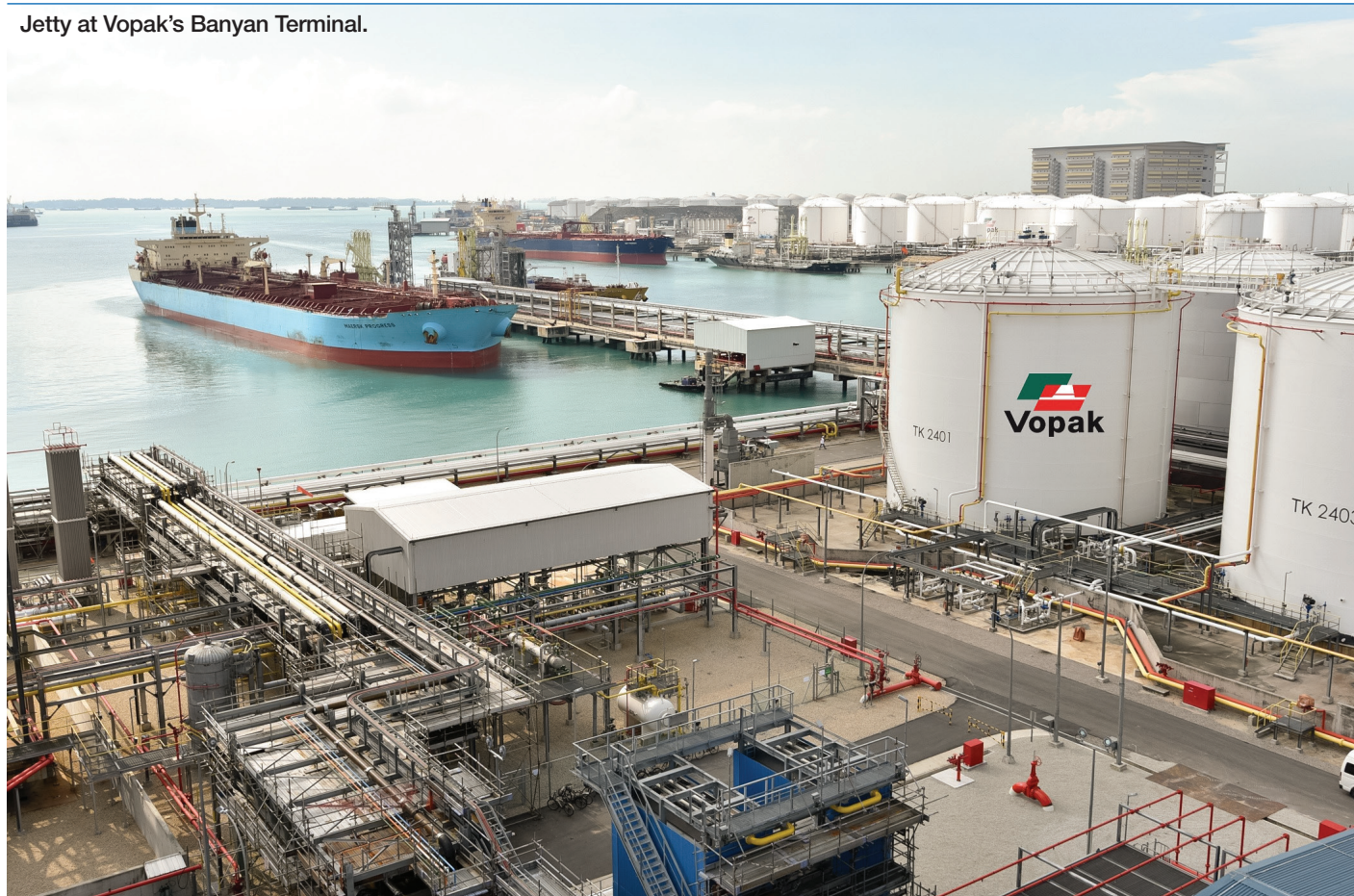
"From the chemical industry perspective, we see those as important trends, evident in the country's commitment towards specialty chemicals such as agricultural chemicals, water treatment chemicals and lubricant additives," said Soo Koong Tan, managing director of Vopak Terminals Singapore.

Singapore's reputation as an efficient infrastructure and logistics hub within the region has attracted a significant number of global chemical majors to the island state. Jurong Island is key to this master plan. It is a hub for the energy and chemical industries as well as for the region, forged through collaboration between Singapore's Economic Development Board (EDB) and the JTC Corporation in the early 1990s.

"Singapore is well placed to serve the Asian market," says Stephen Fowler, general manager of Shell's Jurong Island chemicals manufacturing site. "In addition to large markets like China, the Southeast Asian market in particular is growing rapidly, especially in demand for



Jetty at Vopak's Banyan Terminal.



petrochemicals. Along with that, global demand for petrochemicals is estimated to grow at 3% or more each year. Singapore, which has always been our main hub for refining and petrochemicals, in the region is in a good position.”

Shell is one of the largest refining and petrochemical companies in the world, and has had a presence in Singapore for more than 125 years. The modern presence began in the 1960's with the establishment of Shell's large refinery, the first for the island state. Chevron Oronite's relationship in Singapore dates to the late 1990's when its first production facility was built there. That initial presence itself was fostered by the EDB.

#### Adopting a holistic approach to growth

“We were the third facility to start production on Sakra Island,” says plant general manager Koon Eng Goh “We started construction on Oronite's first facility in 1997 and brought them into service early in 1999. Since 1999, we continued to expand our Singapore facility. Chevron Oronite completed a major expansion in Singapore late in 2017.

“The carboxylate supply-demand balance is such that we needed to add capacity,” says Goh. “Rather than expanding our existing carboxylate facility in France, we wanted to ensure reliable supply to our customers so we decided to take a more holistic approach in deciding where to add additional capacity. The project team adopted a global approach to decide the new carboxylate plant in Singapore.”

At that point Singapore quickly came to the fore. “For us, Singapore was in the top position,” says Goh. “Asia-Pacific is the number-one growth market for us, and we already had a great relationship with the Singapore government that was established over many years. There were a lot of positives. Still, we did a full global analysis with pros and cons of several possi-

ble locations for the new plant, and Singapore won on the merits.”

It is known that the overall cost structure in Singapore is high. “The government is aware of this situation,” says Goh. “So the government and the industry look for other areas and ways to offset. Some things are outside government control. The government led the country and the industry to leverage technology and automation to help the industry to be more competitive. They had also provided encouragement and incentives to upgrade workers skills to meet future requirements.”

Evonik is in the midst of a major expansion at its Singapore complex, which will double its production capacity of amino-acid DL-methionine to 300,000 metric tons per year when it comes into service next year. “By building an additional world-scale methionine plant, it becomes our largest expansion in the region,” says Peter Meinshausen, regional president of Evonik Asia Pacific South. “When it comes into service, it will take our worldwide production of DL-methionine, in which we are the global market leader, to 730,000 metric tons a year.”

While the production expansion in Singapore is under way, Evonik is also growing its research and development capabilities in the near term to serve the long term. A research hub that Meinshausen calls “remarkable” will begin operations in April 2018. It will focus on three areas: functional surfaces, tissue engineering for healthcare, and additive manufacturing for three-dimensional printing. That will include technologies and materials beyond polyamide 12, in which Evonik is active already elsewhere.

“We have our R&D operations in various countries including Germany, Japan, China and the U.S.,” says Meinshausen, “but what drew us to Singapore for this novel research hub is that innovation is



increasingly being done in Asia for Asian customers, and Singapore in particular provides for a best-in-class eco system.”

As an example, Meinshausen cites the academic infrastructure that has been developed in Singapore. “That basis has been supported by the participation of peer companies and industry leaders moving to Singapore. That has created a cocktail of development which is very attractive to us.”

### Spanning the globe

Singapore is connected to 600 ports, which allows specialty chemicals maker Denka to export easily. Also, PSA – the Singapore Port Operator’s efficiency further strengthens Singapore’s competitiveness.

Denka has made use of those advantages to export to more than 50 countries and benefited from free-trade agreements (FTAs). Essentially almost all of its output is exported, “and the FTAs have allowed us to remain competitive through the tariff saving which average around more than 5%,” says Kazuya Tokumoto, managing director, of Denka Chemicals Holdings Asia Pacific.

Denka announced that it will be expanding its IP resin manufacturing in Singapore. “The expansion of IP resin is in line with our business plan to grow our specialty chemical business,” says Tokumoto. IP is an additive to increase the heat resistance for ABS (acrylonitrile butadiene styrene) resin in interior automobile applications such as the use in console and center panel.

Tokumoto credits the Singapore government with having “well-positioned Singapore as a Global-Asia hub. That is an important consideration for manufacturers seeking to tap opportunities offered by a rising Asia. In addition, the well-established FTA network is key to remain competitive, this is further boost by the various incentive Singapore government has provided to encourage companies to innovate to optimize cost and productivity.”

Labor and utilities cost are not the key drivers in determining the site of new plants or expansions, he adds. “Singapore’s availability of professional skilled workers and liberalized electricity and gas markets has provided a platform for Singapore to remain competitive. In addition, in comparison to other country’s labor and utilities cost, Singapore remains highly competitive.”

### Smart plant technology

Predictive maintenance is an area that Denka embraces and will be implementing across plants to ensure safe and reliable operations. “We started that journey with Emerson,” says Tokumoto, “and was introduced the monitoring of the steam traps through digitally connected services. By doing so, we reduced our steam consumption by 7% and planned to continue to evaluate other predictive applications across all our critical equipment.”

One of the big new ideas that a few major producers in Singapore are advancing is the ‘smart plant.’ That can mean different things at different facilities, but it is particularly well advanced at Chevron Oronite Singapore.

“There were pockets of smart-plant expertise within Chevron,” says Goh. “The technology is not new per se, but these are new applications within our company and in the Singapore area. Things like RFID sensors for personnel tracking and underwater drones for infrastructure and equipment inspection.”

In the latter case, using a drone to inspect the company’s jetty is not just more effective, but also much safer. “In the swirling currents of Singapore, underwater drone inspections for the jetty are a much better, safer way of doing things,” says Goh. “It is not cheaper, but definitely better.”

Drones are also used for inspecting cooling towers, and that is cheaper than human inspection, because it means that the towers can stay in operation and so can the process units they serve. “We used to have to drain the water, build a scaffold, and have workers inspect the towers,” says Goh. “There was the time and effort and expense of all of that, as well as lost production time. Now we just drop the drones into the water during operations. There is no downtime, and costs are much lower.”

The broadest application of smart-plant technology is in personnel tracking for safety. “We have people sign in and out, but we can’t keep track of them all the time inside the plant,” says Goh. “The RFID technology allows us to geofence the property. That is especially important for emergency evacuations. The tags are accurate to within a few meters.”

In contrast to that breadth, sensors on specific components adds to time in service and reduced maintenance costs and complications. “We are testing smart sensors on our steam traps,” says Goh. “We have a thousand of them in the plant, and used to have to inspect each trap



Denka plant.

several times a year. But if a trap fails the day after it gets inspected, we would not know about that for some time. Now we know immediately. The sensors are not just for failures, but active analysis of performance.”

Shell is using drones to conduct aerial inspection working with Avetics, a local start-up firm. “We have a global program we call Shell

Chevron Oronite plant.



Evonik DL-methionine plant.



LiveWire for fostering entrepreneurs and small businesses,” says Fowler. “Normally we would have to lower a stack or have someone climb it to inspect it,” says Fowler. “Either way it involved time and expense, and some hazard. The key question was would the images be of sufficient quality for proper inspection? They were and so this application was highly successful. We have also sent remotely-controlled vehicles to do the same thing for underwater inspections.”

More broadly, Shell has an initiative called Advanced Manufacturing because it sees the opportunity to improve its business performance. In addition to drones and robotics is the use of big data analytics through what Shell calls, ‘Getting Ahead of Hindsight.’ Shell Jurong Island is one of the global hubs to develop and trial innovations in Advanced Manufacturing.

One example is the need to maintain safety, quality and productivity during maintenance turnarounds, when there can be thousands of extra workers on the site. “We have been managing many of these large and complex turnarounds, but there is inevitably a safety risk with so many people working in one area, and maintaining the quality of the work is a challenge when so much is going on all at once,” says Fowler. “We were able to make use of support from the EDB for pilot projects in a recent turnaround. We put RFIDs on 100% of the workforce and on some equipment so we knew where everyone and everything was. We also used continuous video monitoring of confined-space access and activities. That is something that has not been applied in Singapore before.”

### Fostering an innovative ecosystem

Singapore’s free trade agreements (FTAs), investment guarantee agreements and avoidance of double taxation agreements make the city-state an appealing place to do business. “Still,” says Tan at Vopak, “in our view, it’s not about savings. We look at it from a more holistic approach for example, the competitive trade conditions struck by trade agencies of Singapore.”

“Singapore has successfully created an ecosystem for the process industry to grow and thrive,” said Tan. “The emphasis on specialties and innovative materials will continue to make Singapore an attractive place for investment. Our outlook on this is positive. As this industry expands, we provide our expertise in terminal operations and push boundaries in productivity and delivering new services that will enhance Singapore’s competitiveness in producing, storing, blending, redistributing and exporting.”

That program is facilitated through four business work streams, adopting a combination of Internet of Things, analytics and robotics. For example, electronic paperless processes in Penjuru, the first Semiotic Labs Sensors for pump monitoring in Sakra and Banyan and semi-robotic tank cleaning at Sebarok. These are aimed towards improving productivity and making the workplace a safer environment to work in.

“There are numerous examples of why conducting businesses and growth in Singapore will continue to thrive while it is not known as a low-cost region,” says Tan. “We see competitiveness as the total cost of ownership, coupled with the opportunities for sustainable growth and maximizing margins as well as the quality of the supporting infrastructures.

Singapore recently began an initiative called the Energy & Chemicals Industry Transformation Map (ITM), which is led by EDB. “The ITM lays out a two prong strategy,” says Damian Chan, executive director, Energy & Chemicals. “First to transform our existing base of chemicals manufacturing through the adoption of innovative technologies and secondly, to diversify into new growth markets and develop new innovation capabilities. The ITM therefore provides a strategic blueprint for us to work closely with companies to plan ahead and develop new strategies to not only ensure Singapore’s competitiveness but for companies to explore new technologies and growth opportunities.”

Cindy Koh, director, Energy & Chemicals adds, “The global specialty chemicals market will grow at a compound annual growth rate (CAGR) of about 5.4% from 2015 to 2025, with Asia Pacific growing at 6.35% CAGR and contributing 45% of the market share. Recognizing the potential of the region, many specialty chemicals manufacturers have since set up a base in Singapore, such as Croda, Solvay and Afton.”

She stresses that “we have identified specialty chemicals as our next engine of growth and have invested in growing it significantly. That is aligned with Singapore’s push towards higher value-added materials that are more resistant to commoditization and are less resource intensive to produce. Diversification down the chemicals value chain adds resilience to our sector.”

For instance, EDB and Singapore’s research agency, A\*STAR have a collaboration to identify scientific and technological needs and gaps of companies, and then invest in developing them so as to support and foster companies’ innovation. “Key capabilities to be developed include chemical synthesis of molecular switches, design and synthesis of polymer structures, target release and delivery, intelligent formulations as well as performance modeling, characterization and analysis,” says Koh. ■