OILS & FATS INTERNATIONAL
SEPT/OCT 2019 ▪ VOL 35 NO 7
WWW.OFIMAGAZINE.COM

MEDIA PARTNER

PIPOC 2019 INTERNATIONAL PALM OIL CONGRESS AND EXHIBITION

INDUSTRY 4.0
Revolution in palm oil

RENDERING
Demand for US fats growing

OILS & FATS INTERNATIONAL

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Revolution in palm oil

The palm oil industry has gone through different stages of industrial revolution. What is the next step to ensure sustainability and efficiency and how can it utilise Industry 4.0 in this journey? *Qua Kiat Seng*

Digital technology is driving exponential changes which are impacting every facet of society. Within a single generation, the world has gone from slide rules and log tables to personal computers and, more recently, cloud-based cognitive systems.

Cognitive computing involves self-learning systems that use data mining, pattern recognition and natural language processing to mimic the way the human brain works.

So how does this new industrial revolution impact the palm oil industry?

Industry development

The Industrial Revolution, now also known as the First Industrial Revolution (Industry 1.0) between around 1760 to 1820-1840, saw the adoption of steam and water power and mechanisation.

Industrial technologies that improved farming included the seed drill, the iron plough and the threshing machine.

Machines and metal working techniques developed in the late 19th century which eventually resulted in the mass production of agricultural equipment such as reapers, binders and combine harvesters.

Industry 2.0 came in the late 1800s, with the advent of assembly lines, mass production and electricity. In the cattle industry, for example, meat packing assembly plants were developed and tallow became more easily available for the oils and fats industry.

In the 1980s, Industry 3.0 introduced computers and automation such as the Programmable Logic Controller (PLC), which revolutionised the automation industry.

And in more recent years, Industry 4.0 has introduced manufacturing to concepts such as cyber technologies, communication through the Internet of Things (IoT), and cloud and cognitive computing (*see Figure 1, p33*).

What is Industry 4.0?

Industry 4.0 is the marriage of advanced manufacturing techniques with information technology (IT), data and analytics.

IT and operations technology (OT) are combined to create value in new and different ways. Underlying this is the availability of advanced manufacturing techniques.

For business operations, the benefits of Industry 4.0 are improvements in productivity and reduction of risks. These risks may be in stocks, process safety, quality and contamination.

This may manifest itself in smart manufacturing and robust supply chain planning. It can also remove workers from dangerous or tedious jobs, and upskill them with the use of modern tools such as tablets, Google Glass and applying advanced analytics to make predictive and proactive actions.

Applications in palm oil

The palm oil industry is at various stages when it comes to Industry 4.0.

To break it down, a palm oil plantation would be at the Industry 1.0 stage, the mill in Industry 2.0 and refinery and oleochemical operations in Industry 3.0, with oleochemicals closest to being at Industry 4.0. But within each sector, you can still find the entire spectrum.

In 1956, oil palm plantations were encouraged under the 1st Malaysian Plan to reduce dependence on natural rubber.

In the 1960s, milling and crushing were the gateway to palm oil processing, first with refining in the 1970s and then with oleochemicals in the 1980s.

Oil palm trees are planted in neat rows, similar to rubber trees, conducive to manual tapping or harvesting.

However, a shortage of labour is now a problem for plantations.

Regular harvesting is a key factor in ensuring quality, including minimising the levels of the process contaminants, 3-MCPDs and GEs.

In response, the Malaysian Palm Oil Board offered a US$1M prize in 2015 for a mechanised harvesting solution. There was no winner and the competition has been closed since 2017. This will remain one of the bigger challenges for the oil palm industry that may need government support and sovereign funds.

In plantations, drones are now increasingly utilised. One application is for applying fertilisers and pesticides. As this is a machine operating a machine, data can be collected and used as an example for the next application. It also removes a health hazard for human workers.

The application of fertilisers and pesticides may increase chlorine levels in palm oil, which can then lead to increased levels of 3-MCPD. The application and use of analytical data in this way is an example of Industry 4.0 in action.

Milling

In milling, it is interesting to note that the 1953 Mongana Report remains an important reference for mill engineers. It highlights how young the sector is. Examples of changes are the different techniques for sterilisation, from hydraulic to screw pressing.

There is also the new Maceration Induced Cell Rupturing Oil Nut Extraction Synthesis (MICRONES) technology, which is a more efficient palm oil extraction method, where the kernel nuts are separated from the palm fruit mesocarp before they enter the press.

A large plantation company has commissioned an upscaled MICRONES plant to be built at one of its mills. This plant incorporates supervisory control and data acquisition (SCADA) technology – which is not widely used in the sector – and will bring the mill up to Industry 3.0, and potentially Industry 4.0, level.

Many milling processes are generally not automated due to the difficulty in measuring multiple phase systems as well as variations in the fresh fruit bunch. Here, soft sensors could be employed.

Soft sensors are inferential models that use easily measured variables to estimate process variables that are hard to measure due to technological limitations.

Refining

Refining began in the 1900s with the vacuum deodorisation of alkali-refined cottonseed oil. The palm oil refining sector has built very rapidly on this.

The first physical refinery in Malaysia in 1974 had a capacity of just 100 tonnes/day. Today, a single fully automated train can process 2,500 tonnes/day.

While a heavy throughput leads to efficiency gains, it also means process control is critical. Physical refining is a compromise between colour, free fatty acid levels and optimised stability.

This will lend itself to data analytics and the attempt to solve the 3-MCPD and GE issue with short time/high temperature bleaching, and longer residence/low temperature deodorisation. Much of palm oil refining is associated with fractionation and crystallisation conditions which can give rise to a wide range of products. Data analytics can fine-tune this to ensure consistency.

The oleochemical industry began in 1903 with the catalytic conversion of fatty acid esters into fatty alcohol. Fat splitting in autoclaves took place in 1905.

The first oleochemical plant in Malaysia in 1980 had a production capacity of 30,000 tonnes/year but this has increased to around 250,000 tonnes/year. Just as with refining, there were efficiency gains, which made process control critical.

Oleochemical producers have said that some benefits of Industry 4.0 are:

- Greater control over quality
- Predictive asset management
- Soft sensors help improve energy usage and plant efficiency
- Convenience of online sales
- 3D visualisation and virtual reality training

Industry 4.0 is not factory limited

Industry 4.0 also affects a company's suppliers and customers.

Modern information and communication technologies being used down the supply chain will allow distributors to detect defects and production failures. This will minimise overproduction ▶

Figure 1: Journey from Industry 1.0 to Industry X.0

Source: IChemE

so there is less waste.

An example of where this is happening is with Roundtable on Sustainable Palm Oil (RSPO) supply chain certification, that tracks and traces the product to ensure it has been sourced from certified plantations. This can be an enormous task and companies use enterprise resource planning (ERP) to manage this. Such tracking and tracing may soon be demanded in the supply chain for assurance on 3-MCPD and GE contaminants.

Blockchain technology could be used to speed up the process, strengthen traceability and reduce costs. But it is not yet proven. It is an online cloud system designed for transparency and efficiency in purchasing a product.

It has already begun to take off in parts of the agricultural sector since it appeals to consumer desire for traceability .

There is a vast disparity in the upstream and downstream sectors of the palm oil industry when it comes to technology that allows automation and ultimately Industry 4.0. This is quite different from the oil and gas industry where upstream and downstream are operations are comparable in technology.

In its 2019 budget, the Malaysian government has allocated RM5bn (US$1.2bn) to propel Malaysian industries in the wake of Industry 4.0.

The uncertain future

Industry 4.0 has prompted concerns over job losses.

However, Simutech wrote that in Germany, Industry 4.0 has resulted in more jobs being created than lost, with these new jobs requring different skills. This means companies will need to retrain their workforce to implement Industry 4.0.

Another issue lies with production-line downtime. Figures from Rutgers University estimates that downtime costs for the food processing industry is US$30,000/hour. Comparatively, the figure for the petrochemical industry is US$87,000/hour.

As more complex machines are intergrated into the supply chain, manufacturing will speed up, meaning every minute of production line activity will become more valuable and downtime becomes exponentially more costly. ●

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