A palm oil newsletter brought to you by
IChemE Palm Oil Processing Special Interest Group

January - June 2020

POPSIG

IChemE

In the News

IChemE ADVANCING CHEMICAL ENGINEERING WORLDWIDE

Palm Oil Processing Special Interest Group

Leadership Team

Chair's Message

The world has become a very different place over the past few months with the outbreak of COVID-19. We planned and edited this issue during and post Movement Control Order in Malaysia. We joined our members in adjusting to work-from-home protocols as businesses closed, and people coped with the uncertainties of life during worldwide pandemic.

In "How Climate Change Fuels Demand for Chemical Engineers", Professor Dato' Dr Ahmad Ibrahim describes how chemical engineering is the most versatile among the engineering courses. Graduates in chemical engineering can work well in many industries, including palm oil processing. In "Spoonful of Palm Oil", Ir. Qua Kiat Seng explains the needs to update the Malaysian Dietary Guidelines 2010 and to initiate further research on the health impact of consuming palm oil. This falls rightly under Chemical Engineering Matters four key challenges of which two are referenced viz Food and Nutrition as well as Health and Wellbeing. Quek Wei Ping, the author of "Solutions by All Sectors to Mitigate 3-MCPDE and GE", tells what he learned from the industry forum on the mitigation of 3-MCPDE and GE that was organised by MOSTA. In "Palm Oil: Better with Enzymes", I explain how enzyme technology could make the palm oil industry greener and more efficient.

Inside we feature three university roadshow events and two evening talks. Both evening talks focus on sustainable palm oil production. Mr. Benjamin Loh from WWF-Malaysia believes that responsible production and sustainable consumption of palm oil through its entire supply chain is vital to the maintenance of biological diversity, ecosystems and natural resources while Mr. Wong Wai Seng from Novozymes Malaysia enlightens how to convert secondary product from palm oil process into biodiesel via enzymatic route.

Also through the first half of the year, we continued our outreach program. POPSIG committees participated the Reach and Remind Friends of the Industry Seminar 2020 & Dialogue organised by MPOC. We were also invited to attend one day session of briefing and discussion for the Technical Committee and the Working Groups on new initiatives in the current review of the MSPO Standards. In addition, our founder member Qua Kiat Seng worked with MoE and MPOC in STEM teachers Train the Trainers Workshop.

I wish you, your family, and your teams good health during this surreal and scary time—and thank you for reading.

We hope you enjoy reading these and the full selection of articles in this issues. Follow us on Facebook, Twitter and LinkedIn.

Chair

Hong Wai Onn

Climate change impact on Palm Oil

The MPOC held its Reach & Remind Friends of the Industry Seminar 2020 & Dialogue on Tuesday, 4th February 2020 at Le Meridien Putrajaya.

Ir. Hong Wai Onn and Ir. Qua Kiat Seng from POPSIG attended the seminar and were pleased to catch up with Tan Sri Emeritus Professor Dr Augustine Ong

YB Teresa Kok said that MSPO certification will reach 70% in the next few days and she will tell the EU when she goes to the EU the following week. She also said that the 2019 novel coronavirus (2019-nCoV) outbreak in China is expected to have a temporary impact on commodities prices, especially crude palm oil (CPO).

YB Teresa Kok, Former Minister of Primary Industries, Malaysia as Guest of Honour delivered the Keynote Address

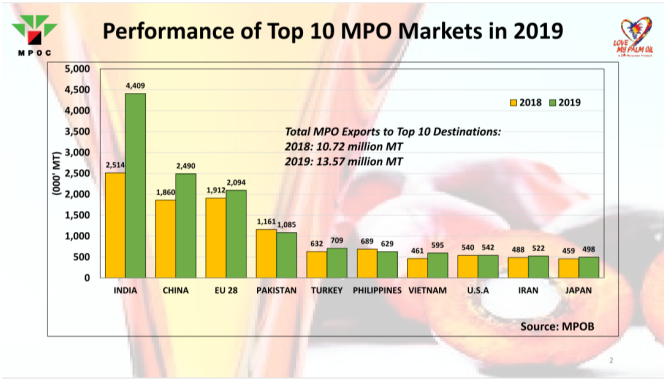
Nafeez Ahmad, a UK Journalist/Author gave a paper "Collapse or Rebirth: The Great Transition to Post-Carbon Civilization" He started by saying that 'climate change is worse than you think' and traced in detail how we arrived at the situation today. An industrial civilization-as-we-know will collapse and a new one will emerge. Whether we evolve or regress is up to us.

The palm oil sector will face a triple threat.

- Due to climate change palm oil yield will drop and palm oil revenue could drop by RM 341/ha for Peninsula Malaysia.
- Palm oil boycott will undermine revenues for palm oil sector
- The boycott will also accelerate deforestation by promoting less efficient oilseeds, incentivising non-sustainability

He made several proposals. One was for Malaysia to get off oil and transition to clean energy that is renewable. Another is for a East-West partnership to tackle global deforestation together.

In his paper "2020 Perspectives: Market, Challenges and Our Promotions" Datuk Dr. Kalyana Sundram, CEO of MPOC warned that although we did very well in 2019 in the top 10 markets we lost share in 10 other markets.



For 2020 he listed a number of upward push factors as well as a number of downward push factors.

Sustainable Palm Oil – Stopping Deforestation and Its Impact on the Environment

Our thanks to Monash University Malaysia MIPO for hosting this talk cum webinar

In line with the Learned Society Committee top three priorities, this talk cum webinar comes under “Responsible Production.” This is POPSIG’s first collaboration with a SIG outside Malaysia viz Food & Drink SIG and we thank them for helping us to reach out to a wider audience.

The speaker Mr. Benjamin Loh from WWF

The speaker was Mr. Benjamin Loh, the Manager for Sustainable Palm Oil under the Sustainable Markets Programme of WWF-Malaysia and within the WWF global network. He has over 10 years of professional experience in the palm oil industry as well as a background in environmental conservation and sustainability management.

The huge demand for palm oil products and massive expansion in the tropics make it a major driver of deforestation and a huge threat to wildlife, such as orangutans, elephants and tigers. Large swathes of land that were once forest, rich with biodiversity and gigantic trees, are today covered with palm oil plantations. However, it is not palm oil that harms the orangutan, nor other agricultural crop that damages the environment. It is unsustainable agricultural production that impacts the environment, affecting natural ecosystems, reducing wildlife habitats, emitting greenhouse gases and polluting freshwater. WWF-Malaysia believes that responsible production and sustainable consumption of palm oil through its entire supply chain is vital to the maintenance of biological diversity, ecosystems and natural resources.

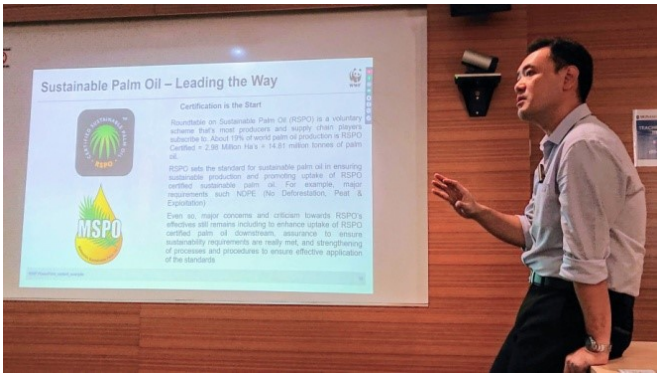
Sustainable palm oil is important because it fulfills increasing global food demand, supports affordable food prices and poverty reduction. As the demand for palm oil steadily increases, it is important for us to ensure that palm oil is sustainably produced, used and consumed. The establishment of palm oil plantations, big or small, must not harm or degrade the environment, and must ensure our fragile ecosystems and wildlife are protected and not adversely affected.

There was a lively discussion not only with the live but also webinar participants. A webinar participant noted that ‘sustainability is very important to European purchasers.’ To the question “How can the issue of creation of small 'islands' of forest be addressed to reduce the impact on arboreal animals?” Mr. Loh gave the Tawau Hill Park in Sabah, Malaysia as an example of the work of WWF with others to conserve a large area of forest in a pristine state.


The participants at the talk

As Mr. Loh's presentation was focused on Malaysia a participant asked how sustainability fared in Indonesia which produces the other two thirds of the global supply of palm oil. Mr. Loh responded (the sustainability record of) Malaysia was very much better. He cited the Tesso Nilo National Park in Sumatra, Indonesia. The park suffers heavy encroachment from illegal loggers and illegal settlers who clear the park for crops and palm oil plantations, as well as village sites.

Participants were keen to make observations. One was that the United States and the European Union seemed 'kinder' to the Latin American countries when it came to deforestation and the impact caused not only by palm oil but also soya bean.



Another observation was on sustainability certifications which was difficult for smallholders to comply with as well as comparing RSPO with MSPO. Mr. Loh said that while WWF believes that all companies should source palm oil that is sustainable, it supports all efforts taken in the direction of making palm oil sustainable and certification can be complemented by other approaches and strong governance.

Mr. Hong, chair of POPSIG presenting a certificate of appreciation to Mr. Loh

Prof Dr. Chan Eng Seng and Ir. Qua Kiat Seng were pleased that a chemical engineering alumnus of Monash University Malaysia is now working for RSPO. Dr. Cheryl Ong (in the middle) is its Research& Advisory Manager

Students find difficulty deciding the right course after high school. Some follow their career dream. A popular approach is looking at the emerging job markets. Parents sometime influence. Engineering and medicine are the popular choice among science students. For the arts students, law and accountancy are largely preferred. There are science students who opt for a course in finance. Graduates in finance have a wider career choice. This is because literally everything involves money.

One way to look at the emerging job opportunities is to look at where business is heading. We are now into an era where technologies literally rule all businesses. Thanks to the global plunge into the digital economy, small businesses are more empowered. If at one time large supermarket chains call the shots, with the advent of e-commerce, the situation has changed. Now everyone, with a bit of entrepreneurship, can compete with the big players and sell to the world. With the emergence of the many social media platforms, promoting the products to the world is no longer costly. It is true as predicted before that the internet's disruptive force in the business world is simply mind boggling. Even the big chain stores are shifting into digital mode.

If digitisation is one important trend in business and industry today, climate change is the other candidate that is increasingly impacting business. The days of ignoring all the evidences presented by scientists on climate change are numbered. More and more are convinced that global warming is indeed happening. Even Australia, now a victim of intense forest burning, is revisiting her policy on decarbonising. Unless the world wakes up and does something to rein in the greenhouse gas emissions, the critical two degrees global temperature rise is not far off. Achieving consensus to take actions is still a struggle. This became clear at the recent UN-IPCC meeting in Madrid. Notwithstanding the lack of consensus, the global shift to the low carbon green economy is already being felt worldwide.

Efforts to embrace non-fossil energy sources are on the rise. Topping the list of renewables are solar and wind. Increasingly, biomass also features as viable candidate to replace fossil fuels. Here at home, the massive amounts of oil palm biomass are being actively developed for commercial use in energy generation. Energy is only one aspect of the growing preference for green sources. The other aspect is the production of renewable chemicals to replace petrochemicals. In Germany, the production of chemicals from renewable sources is already on the verge of commercialisation. The other expanding technology sector which is impinging on business is advanced biotechnology. This involves biochemical processes to not only produce greener products, but also impart better economic value to wastes. The processing of wastes to reduce their negative environmental consequences is also an area of commercial interest.

In the processing of the oil palm fruits to extract palm oil, dealing with the waste residues is a major challenge. Unless properly managed, such wastes can increase GHG emissions, further negating efforts to mitigate climate change. The empty fruit bunches, a major waste source, have been traditionally left to rot in the field to remediate the soil, emitting carbon dioxide in the process. The other major waste component of palm oil processing is the palm oil mill effluent, POME. The usual method to treat POME is through the anaerobic digestion process, normally done in the open pond digesters. The methane gas released is 21 times more potent than carbon dioxide in its global warming effect. Designing new ways to manage such wastes should be another avenue for the deployment of chemical engineers. Already, chemical engineers have developed processes to convert such wastes into heat and energy. In Germany, such lignocellulosic wastes have become the active subject of R&D to produce composite materials as well as generate industrial chemicals.

Energy management is another key area in palm oil milling. The sterilisation process, which is designed to loosen the fruitlets and also arrest the conversion of oil into fatty acid, uses a lot of energy and water. Reducing the energy and water usage present another challenge for chemical engineers. There have been efforts to use a dry sterilisation process using microwave instead of the high-pressure steam, but the performance has not matched the current design. It needs more innovative thinking by chemical engineers.

How Climate Change Fuels Demand for Chemical Engineers

By

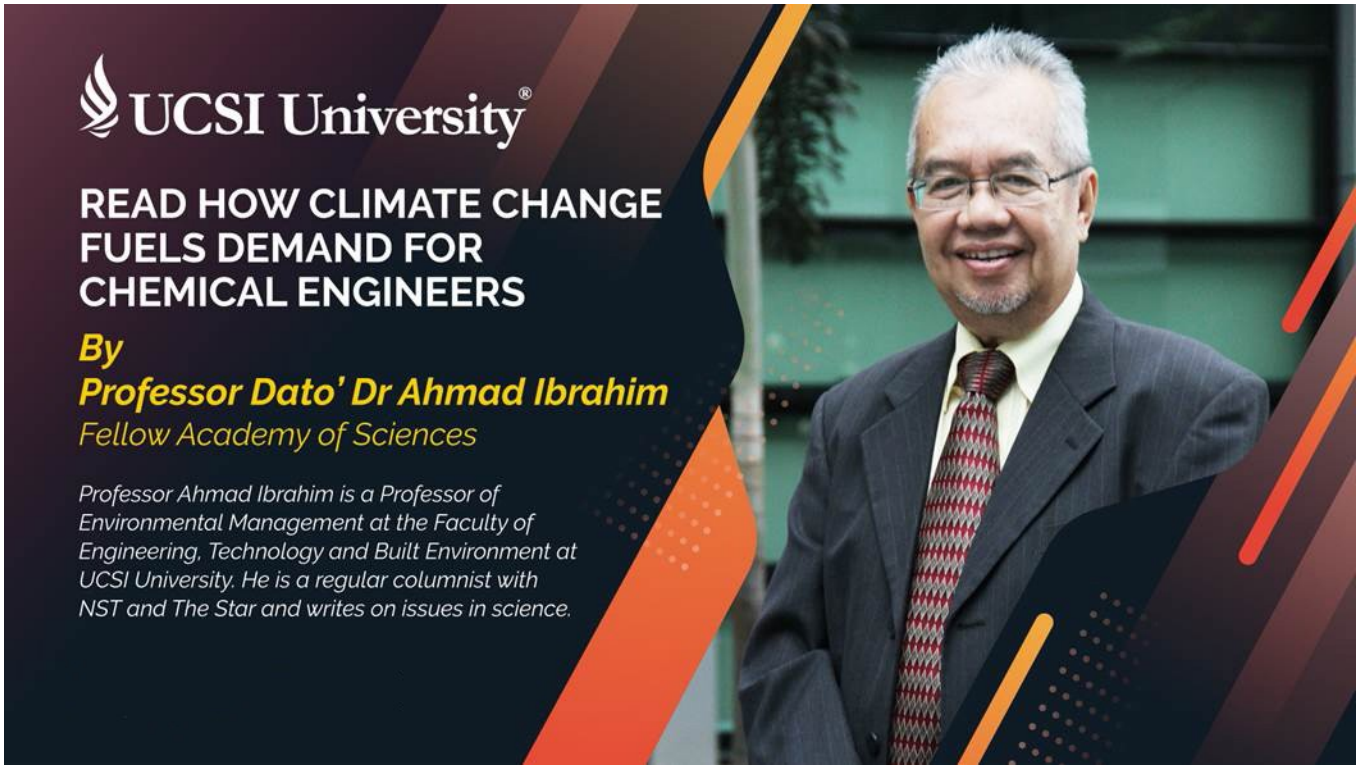
Professor Dato' Dr Ahmad Ibrahim

Continues on Page 7

From Page 6

The expanding green economy, as part of the response to mitigate climate change, is inadvertently giving rise to a growing demand for chemical engineers. This is because the production of green products, including the renewable fuels, involves a lot of chemical processing. Whilst the deployment of advanced biotechnology in wastes management and the pharmaceutical sector involves knowledge in chemical process design and operation. Chemical engineers are best suited to handle such job demands. It is no wonder that the number of universities offering chemical engineering courses are also on the rise. At many of the private universities, most engineering students take chemical engineering. Many international students are also opting for chemical engineering. UCSI university which is the nation's top private university has become popular among students pursuing chemical engineering. This is set to rise.

Admittedly, chemical engineering is the most versatile among the engineering courses. Graduates in chemical engineering can work well in many industries. Though in the past, the oil and gas sector had absorbed most of the chemical engineers, in the coming years, with the advent of climate change, the demand for chemical engineers in the green economy is destined to rise.



POPSIG works with MoE and MPOC in STEM teachers Train the Trainers Workshop

POPSIG was there at the 'Share a Sawit Moment' STEM Workshop from 10 -12th February 2020 at Pusat Kecemerlangan Kejuruteraan & Teknologi JKR, Alor Gajah, Malacca. This is for science and chemistry teachers in Negeri Sembilan, Malacca and Johore.

During the ice breaker on the first evening it was very encouraging to see the enthusiasm of the 40 teachers and 36 officers from the Ministry of Education at both the state and district levels.

The ice breaker event

There was also a briefing on the STEM initiative and familiarisation with palm oil that is included in the Form 5 syllabus.

The next morning Puan Razita Abdul Razak of MPOC spoke about the history of palm oil and the role it played in our economy and nutrition.

Ir. Qua Kiat Seng representing IChemE and POPSIG then delivered his presentation "Introduction to Oleochemicals". He started by comparing chemistry with chemical engineering and told the teachers they were also preparing future engineers. He then explained oleochemistry and invited the participation of the teachers to demonstrate the role of a catalyst by using a marriage matchmaker scenario for the hydrogenation of linolenic acid.

Ir. Qua presenting "Introduction to Oleochemicals"

He then explained the many oleochemical processes and showed that there were many oleochemicals in an every day body wash. He then showed the tremendous value added to palm oil as an oleochemical and how it contributed to the import revenue of Malaysia.

The attentive teachers

He was impressed with the questions posed by the teachers as it showed they had familiarised themselves with palm oil and how they would teach their students.

Ir. Qua showing the teachers some of the palm oil products. He advised them to always study the labels which listed the ingredients

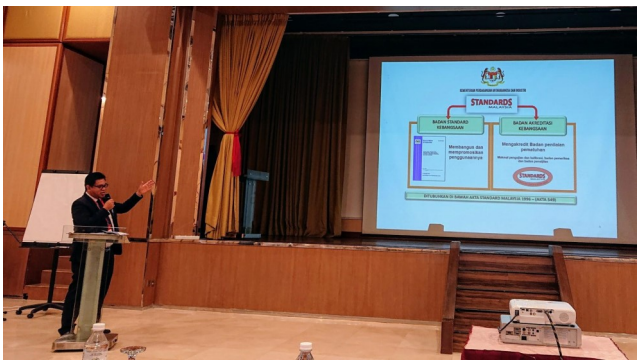
POPSIG offered to assist MPOC and MoE in future activities.

MSPO mulls incorporation of new initiatives

On 18th February 2020 the MSPO organised a one day session of briefing and discussion for the Technical Committee and the Working Groups on new initiatives in the current review of the MSPO Standards, MS2530:2013.

Three IChemE members were there. They were Prof. Denny Ng representing ARPOS*, Ir. Hong Wai Onn representing Novozymes and Ir. Qua Kiat Seng representing POPSIG. Prof. Ng is also the chair of Working Group 4.

Left to Right: Ir. Qua, Prof. Ng, Chew Jit Seng CEO of MPOCC and Ir. Hong

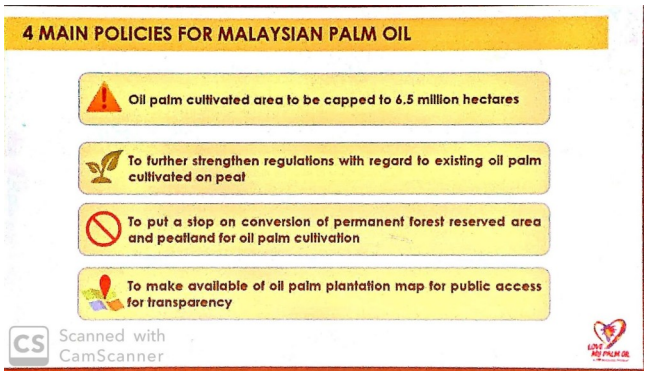


The first presentation was from Standards Malaysia on National & International Standards by En. Hussalmizza Hussein.

The second presentation was by Assoc. Prof. Dr Azizan Marzuki from Universiti Sains Malaysia on Social Impact Assessment.

The third presentation was by Dr Elizabeth M P Philip from the Ministry of Energy, Science, Technology, Environment & Climate Change. She spoke on climate change & forest, UN Convention on Biodiversity and National Biodiversity Policy, forest & deforestation and High Conservation Value & High Biodiversity Value. She elaborated on how Malaysia participates in the UN Intergovernmental Panel on Climate Change.

The final presentation was by Encik Hadrian Numpang anak Hollis Awell from the Ministry of Primary Industries. He briefed on High Level Policies for Malaysia's Palm Oil Industry.



These are the policies that will enhance the revised MSPO Standards.

POPSIG welcomes these progressive developments.

A Spoonful Of Palm Oil

by Ir. ChM Qua Kiat Seng

Introduction

In this continuation of previous article “Make MY Palm Oil a Great Brand” I wrote for The Edge Malaysia Weekly, on March 25, 2019 - March 31, 2019, a review of the progress is now being made. It is recommended that the Ministry of Health updates the Malaysian Dietary Guidelines 2010. It is also proposed that the Council of Palm Oil Producing Countries initiate further research on the health impact of consuming palm oil.

Health and nutrition

In March I wrote “Work needs to continue on health which I am confident will in due course be properly documented and substantiated but it will be generic to palm oil.” In the course of my investigations over the past year I discovered there is a lot more and important work that needs to be done and it needs to cover nutrition as well.

Dietary guidelines

In April 2019 in the Dewan Rakyat when YBM Teresa Kok urged MPs to consume a spoonful of red palm oil to stay young and healthy, she drew laughter. She said correctly that red palm oil is rich in nutrients such as vitamin E, carotenoids, anti-oxidants and has no trans fat. Although she was teased on social media, she accepted it well because it helped to draw more public interest to the ‘Love MY Palm Oil’ campaign.

To be exact it is two US tablespoons of red palm oil. An authoritative source for two tablespoons of edible oil is the U.S. Department of Health and Human Services and U.S. Department of Agriculture. 2015–2020 Dietary Guidelines for Americans. 8th Edition. December 2015. It provides nutritional advice for Americans. The Guidelines were established so as to provide dietary advice that would improve the health of Americans and reduce their risk for many chronic conditions and diseases, such as cancer, atherosclerosis, hypertension, heart disease, stroke, and renal disease. Whilst it is not perfect it is a model followed by many countries such as Canada, Australia and the UK which consume culturally similar diet. Guidelines were developed following a review of scientific evidence.

In Appendix 3 Table A3-1 under ‘Oil’ for a calorie level of 2000, only 27 g of oil is recommended. This equate to 2 tablespoons. Oils and fats provide an essential macronutrient and help to improve palatability, aid the release of flavours and aromas of meals and contribute to the feeling of satiety. The guidelines emphasize replacing saturated fats with unsaturated fats, particularly polyunsaturated fats, with the goal of preventing heart attack and stroke. It points out that palm kernel oil and palm oil contain the greatest amount of saturated fats. The development of the 2020–2025 Dietary Guidelines is currently in progress and if it is perceived there is no new scientific evidence the recommendation on saturated fats is unlikely to change.

Diseases such as heart and lung disease, cancer and diabetes are costly health conditions as well as leading causes of death and disability. The Malaysian Dietary Guidelines 2010 by the Ministry of Health should be updated to effectively address current local issues such as obesity and diabetes. It should also be made easily accessible as well as easy to understand and apply.

In 2020 Malaysia will introduce a free breakfast programme for children in primary schools and may in the future extend to lunches. In Japan school lunches score high for nutrition resulting in very low obesity rates. If we can prove the benefit in children after many years of a successful breakfast programme it will be manifested in these children as healthy adults. Parents and grandparents get educated too and it will be easier for them to embrace and apply the same dietary guidelines.

The programme will certainly refer to the Malaysian Dietary Guidelines for Children and Adolescents 2014 to formulate the meal patterns and nutrition. Issues of overweight incidence and obesity prevalence should be addressed. Under Key Message 10 “Include Appropriate Amounts and Types of Fats in the Diets” our nutritionists make the same recommendations as the USDA Dietary Guidelines to limit the intake of saturated fats and to “Cook food using a blended vegetable oil high in PUFAs (polyunsaturated fatty acids), e.g. palm oil with soya oil, palm oil with corn oil, or palm oil with sunflower oil.”

Continues on Page 11

From Page 10

Our nutritionists appear to be only guided by international community norm. There is already much scientific evidence produced by not only by our scientists in Malaysia, Australia, China and others that show that saturated fatty acids in palm oil triglycerides are chemically positioned to be poorly absorbed so that the cholesterolemic effects for healthy adults are similar to extra virgin olive oil. This means the intake of palm oil can be higher than stipulated by US guidelines as moderate consumption by healthy individuals has been proven healthy. Malaysian nutritionists should take the lead in setting new guidelines for the intake of palm oil.

Scientific evidence

The fear of saturated fats started in late 1950s when American physiologist Dr Ancel Keys reported the results of what came to be known as the Seven Countries Study, actually Six-Countries Study. Saturated animal fats became associated with increased cardiovascular risk and in 1990s animal fats, e.g. butter was replaced by margarines which required hydrogenation of vegetable oils. It was evident that the Keys study was flawed and based on cherry picking data from six countries but it was only after almost 50 years that this information was publicly released by the authorities. It is difficult for the US scientists and nutritionists to retract the huge documentation resulting from the false science of Keys as well the large number of scientists following this dogma.

Between 2000 and 2010 the truth had to be revealed to the public that trans fats from partial hydrogenation in the use of polyunsaturated oils had detrimental effects on health (cardiovascular as well as many other aspects). From the health perspective pressure on palm oil decreased but it has moved to deforestation and sustainability.

Modern nutrition however is still stuck on saturated fat intake, that it should not exceed 10% of the total energy intake. There are indications to warrant the gathering of more evidence for palm oil intake to be higher. Fats in food are composed of triglycerides which need to be hydrolyzed into fatty acids and glycerol before it is absorbed into the body. How the fatty acids are attached to the skeleton of the glycerol in the triglyceride molecule determines its absorption. As palm oil saturated fatty acids (SFA) are mostly in positions sn-1 and sn-3, SFA absorption is lower and hence its potentially negative effects for cholesterolemic parameters are also lower. Already, from previous research and more recently the randomized controlled trials with palm olein by Yang et al (2018) and Stonehouse et al (2019) demonstrated this in healthy young adults.

Therefore, scientific research including clinical trials must be done on:

- The impact of consuming palm oil on non-communicable diseases (NCDs) such as cancer, atherosclerosis, hypertension, heart disease, stroke, renal disease, obesity, diabetes, etc.
- The full nutritional data on palm oil.
- Health benefits of phytonutrients in palm oil.
- Fat requirements of infants and young children.

Such research should be as numerous as possible and conducted by institutions that are independent and credible to populate the data base so as to assist countries to construct their dietary guidelines as well as to be used by food manufacturers. As the results will benefit palm oil producing countries the research should be initiated by the Council of Palm Oil Producing Countries (CPOPC). The current members of CPOPC are Indonesia Malaysia and Colombia.

One of the platforms to make these research results freely available is PubMed.

PubMed

PubMed is a free resource supporting the search and retrieval of peer-reviewed biomedical and life sciences literature with the aim of improving health–both globally and personally. The PubMed database contains more than 30 million citations and abstracts. Available to the public online since 1996, PubMed was developed and is maintained by the National Center for Biotechnology Information (NCBI), at the U.S. National Library of Medicine (NLM), located at the National Institutes of Health (NIH). As examples the two articles below can be found in PubMed.

Pascual et al. 2016 published a study ‘Targeting metastasis-initiating cells through the fatty acid receptor CD36’ showing that palmitic acid causes cancer in mice. Datuk Dr Kalyana Sundram, CEO of the Malaysian Palm Oil Council (MPOC) reviewed the study. He noted that it was a lard-soyabean oil combination fat source in the test diet. Lard is a rich source of saturated palmitic and stearic acids. Palm oil was not used in the study. He said, “Although the researchers did not in any way implicate palm oil, Worldwide Cancer Research and ScienceDaily were quick to unjustifiably associate palm oil with cancer due to its high palmitic acid content.” Media reports frequently use facts to draw wrong conclusions.

Continues on Page 12

From Page 11

In January 2019 an article “The Palm Oil Industry and Non Communicable Diseases” published in the World Health Organisation (WHO) Bulletin, in its conclusion drew parallels between the palm oil industry and tobacco and alcohol lobbyists. The WHO Representative to Malaysia, Brunei Darussalam and Singapore clarified that it was not a WHO study but refused to retract the article. The article remains and if you did not follow the news in Malaysia, you would believe it to be true. The palm oil community could write at least one counter article and have it published in PubMed.

The data submitted and accepted into the component data base structure stays available for a long time. There is little data available for palm oil and the various palm fractions and products. Much of the data was submitted before the advice on the declaration of trans fat was issued. The data on palm products covers the macro nutrients only, the exception seems to be data produced by individual researchers looking for other nutrients, e.g. vitamin K and tocotrienols.

Many of the formulation programs that guide businesses, not only in America but also in many Western Countries, are based on the data in the data bases. The programs also produce the labelling information based on the component parts. One product from palm oil which appears to feature is the ‘Shortening’ – saturated fats – used in pies and pastries. It is clearly more difficult to expand marketing in the Western Countries if the main nutrient of palm oil that features is the saturated fat part of the wide range of products that can be made from palm oil.

Also in PubMed can be found “Palm Oil on the Edge”. Internationally recognized Spanish experts in the food industry, nutrition, toxicology, sustainability, and veterinary science met in Madrid on July 2018 to develop a consensus about palm oil (PO) as a food ingredient. Their review is positive showing a lot of work has been done to show that there is no evidence associating palm oil consumption with higher cancer risk, incidence or mortality in humans. They lament that the absence of any pronouncement from the scientific community regarding the effects of palm oil on consumer health has meant that the message that reaches the general public is often skewed and incomplete.

Conclusion

Palm oil is a major fruit and seed oil source that is the most sustainable due to its highest yield, quality characteristics and mandatory adherence to certifications (mostly MSPO and also voluntarily RSPO and ISCC) to help feed the global population that will grow from 7.7 billion to 9.7 billion in 2050 with the world oils & fats consumption projected to increase from 180 million MT to 250 million MT. There should be no health or nutrition concerns about palm oil but like sustainability there must be continuing efforts to reinforce the facts about palm oil if it is to gain its rightful place as being essential to food security.

Acknowledgment.

I am indebted to YBhg. Academician Tan Sri Emeritus Professor Datuk Dr. Augustine S.H.Ong for drawing my attention to recent publications.

Source: Malaysian Oil Science and Technology 2019 Vol. 28 No. 2

Solutions by All Sectors to Mitigate 3-MCPDE and GE

by Quek Wei Ping

An industry forum on the mitigation of 3-MCPDE and GE was recently held on the 20th February 2020 in PAUM Club House at University of Malaya. The forum was organised by Malaysian Oil Scientists' & Technologists' Association (MOSTA). The forum brought together over 100 participants from different background i.e. R&D personnel, engineers, millers and planters in the palm oil industry to discuss possible solutions to mitigate the formation of 3-MCPDE and GE mitigation during refining.

At the start of the forum, the president of MOSTA, Tan Sri Dr Augustine Ong gave a welcoming speech followed by the presentations by three leading technology solution providers namely Alfa Laval, Desmet Ballestra and JJ-Lurgi Engineering. In the afternoon, Novozymes Malaysia and Sumwin Solutions Malaysia shared their mitigation process solutions, followed by a panel discussion on the questions raised by the participants.

It is encouraging to see that the industry players are able to respond to the challenges and develop practical solutions that can meet the new food safety requirements set the by European Union with respect to 3-MCPDE and GE. In his closing remarks, Tan Sri Ong emphasized the need for all stakeholders to work together and to continuously improve the quality of palm oil and its reputation.

* * *

Quek Wei Ping from Monash University Malaysia is a recipient of the POPSIG Student Bursary.

Participants listened to the presentation by Desmet Ballestra

Quek Wei Ping and Prof. Chan Eng Seng from Monash University Malaysia attended the forum and were pleased to catch up with Tan Sri Emeritus Professor Dr Augustine Ong

Did you know that POPSIG offers Student Bursary?

Palm Oil Processing Special Interest Group (POPSIG) provides financial assistance in a form of student bursaries to undergraduate and postgraduate students to attend scientific conferences, workshops or forums which are related to palm oil processing. The main objectives of such assistance are to spur the students' motivation and support their research in palm oil processing. The student bursaries contribute towards the registration, travel and accommodation costs to help make the palm oil processing conferences or events more accessible to the students. For more information go to here.

POPSIG University Roadshow: UKM

On 19th February 2020, the Palm Oil Processing Special Interest Group (POPSIG), IChemE and the Chemical Engineering Student Club (CHESC), UKM jointly organized the POPSIG University Roadshow @ UKM at the Auditorium, Perpustakaan Lingkungan Dua UKM. The event was attended by participants which consists of chemical engineering undergraduates, postgraduates and researchers from various field in the university. The event was officiated by Professor Dr Jamaliah Jahim, the Chairperson of the Department of Chemical and Process Engineering (JKKP) with a welcoming speech to the speakers and all the participants.

Professor Dr Jamaliah Jahim giving welcoming speech

The event then started with an introductory talk given by Ir. Qua Kiat Seng, the founder of POPSIG IChemE, on the founding of POPSIG. POPSIG was formed on 3rd August 2015 in Kuala Lumpur, Malaysia to provide a forum for people (not only chemical engineers) who are passionate about the palm oil industry and process engineering to exchange of ideas, share experiences and encourage innovation in the palm oil processing industry. In addition, the group also serves as a channel to promote the professional aspect of the palm oil industry and acts as a focal point for all those interested in the process aspects of the palm oil processing. To achieve all its objectives, POPSIG has actively organized technical seminars and webinars, workshops, physical evening talks and site visits. The group also raise awareness of the palm oil industry through quarterly newsletters and yearly forums. To appreciate and encourage more innovations among students and industrialists in the palm oil industry, POPSIG actively supports awards such as the Best Final Year Design Award and the annual IChemE Malaysia Palm Oil Industry Award. Bursaries are also awarded to students to attend scientific conferences, workshops and forums related to the palm oil industry as to spur their motivations and support their research in the palm oil industry.

Next, Mr. Ahmad Shahdan from Malaysian Palm Oil Council (MPOC) presented on the overview of the palm oil and the initiatives taken by various parties in the country towards a sustainable palm oil industry. Palm oil is a nutritionally balanced oil is which presence in almost all food and non-food products such as cereal, chocolate, household detergents, skincare and body care products, cosmetics etc. Due to the versatility of the palm oil, the Malaysian palm oil industry has provided livelihood to millions, making large economic contributions to the nation and even the world. Strict quality control measures were implemented to ensure the highest product quality and the sustainability of the industry. Such measures include Malaysian Sustainable Palm Oil (MSPO) certification scheme, Good Agricultural Practice (GAP), Malaysian Palm Oil Green Conservation Foundation (MPOGCF) and many more. The session was ended with the introduction of the “Love MY Palm Oil” campaign, which was launched by MPOC in 2019, with the purpose to promote and raise awareness on the Malaysian Palm Oil throughout the country. In this campaign, a student ambassador programme was initiated and still ongoing to enable the youths to recognize and appreciate the vital role of palm oil and the industry to the country.

After the refreshment session, the event was continued by Ms Liew Sin Lu from Desmet Ballestra Malaysia who gave the participants an insight of the palm oil processing industry as well as the role of chemical engineer in such industry. Malaysia is the 2nd largest palm oil producer and exporter with 10% of the world’s oils and fats production. 17.5% of the land mass (equivalent to 5.8 million hectares) is used for the oil palm plantation activity. The palm oil processing value chain can be categorized into three sections: upstream (palm oil milling), midstream (palm oil refining) and downstream (specialty fat, oleochemicals and biodiesel production. The process pathways and the technologies utilized in each section were introduced in this session. Ms Liew also explained that chemical engineers have a wide career options in palm oil processing industry such as front-end engineering design, plant operation, quality assurance, R&D, continuous improvement and technical sales and marketing due to their various technical knowledge in chemical engineering. Challenges lying ahead for the palm oil processing industry includes the process efficiency, oil quality and process sustainability. Hence, the industry expects the chemical engineers nowadays to be able to apply knowledge and understanding to practical situations, manage interpersonal relationships and demonstrate leadership skills, commit to high standards of professional and ethical conducts, and commit to continuous professional development related to professional knowledge and competency.

Continues on Page 15

From Page 14

Ms Liew then ended her presentation by encouraging the participants to always develop and excel by giving the three principles: Connect to Create, Back to Basics, Uphold Professionalism.

Ms Theresa Lok from IChemE continued the session with her presentation on becoming a Chartered Engineer. Throughout the session, the participants were introduced to the importance and benefits of becoming a Chartered Engineer. They were also briefed on the mechanism use to become a Chartered Engineer which is the Competence and Commitment Report. The participants especially the chemical engineering students were encouraged to pursue the path of becoming a Chartered Engineer.

After the four talks, a forum was held between the four speakers and the participants, moderated by Adjunct Professor Dr Mohd Tushirin Hj Mohd Nor from Department of Chemical and Process Engineering. Several issues were raised and discussed during the forum including the sustainability of the palm oil in Malaysia and Indonesia, the import ban by India towards Malaysia palm oil, digitalization in the palm oil industry and many more. In conclusion, a lot have been done to achieve sustainability in the palm oil industry but continuous improvement and development in various fields such as technology, social and economy are needed to ensure the advancement of the industry in the future.

Lastly, the event was continued with the souvenir giving session by Professor Tan Sri Dato' Seri Dr Noor Azlan Ghazali, former Vice Chancellor of Universiti Kebangsaan Malaysia and Dr Teow Yeit Haan, the supervisor of POPSIG University Roadshow @ UKM to the speakers and then ended with group photo session with all the participants. The speakers and VIPs were invited for a lunch session after the event.

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1. Ir. Qua Kiat Seng giving talk on "Introduction to POPSIG"
2. Mr Ahmad Shahdan giving talk on "Know Your Palm Oil"
3. Thank Ms Liew Sin Lu giving talk on "Role of Chemical Engineers in Palm Oil Industry"
4. Adjunct Professor Dr Mohd Tushirin Hj Mohd Nor moderating the panel discussion

POPSIG University Roadshow: UCSI University

UCSI University is our sixth station of University Roadshow 2019-2020.

The event started by a welcoming speech by Asst. Prof. Dr. Lee Kiat Moon, Head of Department of Chemical & Petroleum Engineering. This is followed by an introduction to IChemE POPSIG given by Ir. Qua Kiat Seng, LSC member of IChemE. Later, Mr. Mohd Muslimin Hashim, Science and Environment Manager from MPOC, shared a topic related to the truth about palm oil from health and nutrition perspectives.

After a short break with refreshments, Hong Wai Onn, Chair of IChemE POPSIG., discussed on the needs and role of Chemical Engineers in the palm oil industry. This is followed by a short session by Theresa Lok, who briefed students on continuous professional development by getting charteredship with IChemE. After that, there was a panel discussion led by speakers and Professor Dato' Dr Ahmad Ibrahim from Faculty of Engineering, technology, and Built Environment. Finally, Mr. Mohd Muslimin introduced the Student Ambassador Programme.

Converting Secondary or Waste Oil Into Biodiesel via the Enzymatic way

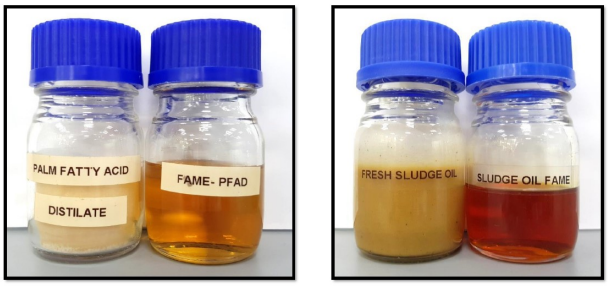
This webinar was delivered by Mr. Wong Wai Seng on Monday 9th March 2020.

Mr. Wong has 10-year experience in vegetable oil and fat processing line, particularly in enzyme technology that covers both upstream (palm oil extraction) and downstream application (refining, interesterification, FFA remedial, condensation and FAME synthesis). He has worked with Loders Croklaan for 5 years by leading the R&D team to produce OPO fat for infant formula, as well as SOS for shea stearin replacer in CBE production.

Recycling of POME sludge and other waste streams causes severe degradation of CPO quality. Finding alternative uses for these secondary products had been difficult because of high levels of FFA and impurities. But, this could be addressed by enzymatic way. Mr. Wong explained that liquid enzymes have recently been shown to catalyze the transesterification and esterification of glycerides and fatty acids components in these waste oils at lower temperatures of about 40°C, ambient pressure and with high rates of conversion. He further elaborated that laboratory and plant scale trials shown over 90% conversion of esterifiable components with 2-3% of FFA.

Mr. Wong added that this conversion has been demonstrated and proven on a commercial scale and is increasingly adopted by the industry to produce high quality methyl esters that meets the EN/ASTM specification, although further distillation to remove non-esterifable residues and sulphur are required.

Example of enzymatic FAME from PFAD and Sludge oil



Plant Visit To Oleon (Malaysia) Sdn Bhd

On 19th February 2020, 30 participants comprising of chemical engineering undergraduates, a department staff and a lecturer of UKM visited Oleon (Malaysia) Sdn Bhd located at Port Klang courtesy of POPSIG. The participants were welcomed by Mr Micky, the R&D executive of Oleon, as they arrived at 2.30 pm. Firstly, the participants were introduced on the history of Oleon and the overview of the production facilities in Malaysia via the corporate video clip. Next, a safety briefing was conducted by the safety officer through the safety video clip. This is to ensure that the participants were well informed of the hazards in the plant as well as the rules to be followed throughout the visit. The participants were then separated into two groups so that the lab and plant tours could be conducted simultaneously.

During the lab tour, the participants visited the Synthesis Laboratory where the formulation of vegetable oil-based lubricant formulations are made and tested. They also visited the Cosmetic and Food Laboratory where the research officer demonstrated the preparation of emulsifier, an important ingredient for both cosmetic and food applications. As for the plant tour, the participants were shown one of the three ester plants in the production facility. The ester plant produces fatty ester by using fatty acid and fatty alcohol as raw materials.

The production of fatty ester is a batch process where the plant includes pre-heating tanks, reactor, distillation column, evaporator, and deodorizer. The process engineer explained the functions and working principles of each unit operation in detailed along the tour.

A short closing ceremony was conducted where a souvenir was given to the production manager of Oleon by Dr Nur Hidayatul Nazirah Kamarudin, the senior lecturer of JKKP. The visit ended with a group photo at the lobby of the administration office.

On behalf of the Department of Chemical and Process Engineering UKM, we would like to express our utmost gratitude to POPSIG for selecting our campus as of the stop for the university roadshow. We wish POPSIG all the best in their upcoming roadshows, and we look forward for more cooperation in organizing such event in the future.

Mr Micky conducting the introduction session in the meeting room before the visit

Group photo session at the administration office lobby

POPSIG University Roadshow: Heriot-Watt University

Over the past few decades, Malaysia's palm oil industry has grown into importance, serving an integral part in supporting and driving the regional economy. In an effort to promote awareness surrounding the palm oil industry, Palm Oil Processing Special Interest Group (POPSIG) university roadshow was held on the 4th of March 2020 in Heriot-Watt University from 2PM to 5PM. IChemE's POPSIG as well as Heriot-Watt University's IChemE Student Chapter jointly organized the university roadshow. Eloquent speakers from IChemE POPSIG, the Malaysia Palm Oil Council (MPOC), Novozymes, a global biotechnology company as well as KLK Oleo, an oleochemical company were invited to enlighten participants of the palm oil industry. The university roadshow attracted a good amount of participants, mainly consisting 99 undergraduate students, staff members, as well as a few external participants outside of Heriot-Watt University.

Participants and speakers

Professor Ir. Dr. Denny Ng Kok Sum, the university's Associate Head of School of Engineering and Physical Sciences, kicked off the roadshow with a welcoming speech. This was then followed by an introduction of IChemE POPSIG by Dr. Viknesh Andiappan, an exco-member as well an Assistant Professor in Heriot-Watt University. He provided the participants a deeper insight into the foundation and purpose behind POPSIG.

Next, Dr. Yew Foong Kheong of the Malaysian Palm Oil Council (MPOC) delivered his presentation regarding the truth about palm oil, clearing the air about misleading information against the global palm oil industry.

Participants were then asked to take a break with a variety of refreshments served. Participants were also reminded to ask their questions through an interactive Q&A platform, to be discussed during the discussion panel.

Following this, Ir. Hong Wai Onn, the current Honorary Secretary of IChemE in Malaysia Board, Chair of IChemE POPSIG as well as a technical service manager at Novozymes with more than 10 years of operational experience in the palm oil industry was invited to enlighten participants of the role of chemical engineers in the palm oil industry.

As important as it is to understand the role that chemical engineers play in the palm oil industry, it is of equal importance for the participants mainly consisting undergraduates pursuing chemical engineering, to understand the importance of being chartered in the development of a professional career as a chemical engineer. Thus, Ms. Theresa Lok, an associate member of IChemE was invited to deliver her presentation regarding getting chartered.

After the series of well-spoken speeches by the invited speakers, an insightful and interesting panel discussion session took place where Ir. Dr. Calvin Chok, a technology manager at KLK Oleomas was invited to participate as a panelist as well.

The university roadshow ended with a small gesture of appreciation from the university, presenting the speakers a small token of appreciation. The IChemE student chapter of Heriot-Watt is extremely thankful for the time and effort the speakers took to share their insightful knowledge.

Panel discussion session taking place

IChemE Malaysia Awards 2020

The Malaysia Awards celebrate excellence and innovation in various fields of chemical engineering and is an excellent avenue for teams, companies, or individuals to have their projects recognised on a national platform. The Awards are free to enter and open to all chemical engineers in Malaysia, both members and non-members.

The IChemE Malaysia Awards offers various categories, including **Palm Oil Award**. This award recognises the best project implemented and demonstrates innovation, successful delivery and a technical, commercial, safety and/or environmental benefit. The project may relate to new industrial plant or to the enhancement of existing palm oil mills, refining and other related industries. You may download an entry form here.

Deadline for entry submission is **Friday, 26 June 2020**.

Winners will be announced at the IChemE Malaysia Awards 2020 on 19 October in Kuala Lumpur.

Palm Oil Award Winners

2019: Enzymatic Assisted Extraction of Palm Oil by Sime Darby Research and Novozymes Malaysia

2018: Heat Recovery Using Vent Economisers by Chong Tze Haw and Hassan Abas, IOI Edible Oils Sdn. Bhd. in Sandakan, Sabah, Malaysia

2017: Novel integrated process for the extraction of phytonutrients and production of biodiesel from crude palm oil by Sime Darby Sdn. Bhd

2016: Re-engineering current palm oil degumming process by Muhammad Saiful Nidzam Ismail, Senior chemical engineer in Oils & Fats Refinery Technical Advisory Services Units, Sime Darby Research Sdn. Bhd.

2015: Palm oil olein yield improvement project by Toh Seong Hin, Asst VP, Plantation Advisory (Refinery), Sime Darby Plantation Sdn Bhd

Palm Oil: Better with Enzymes

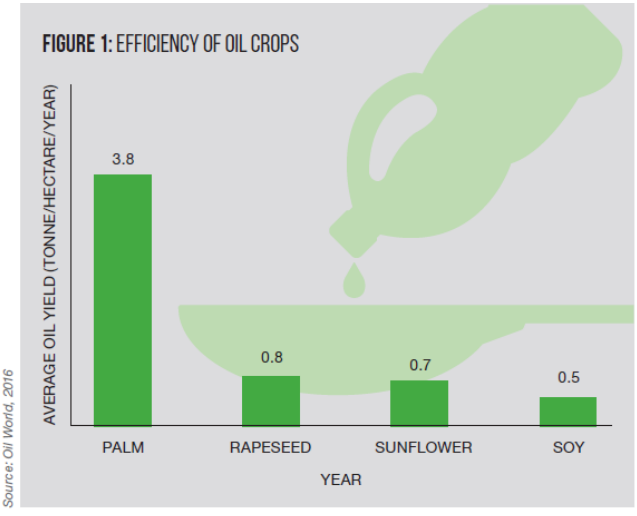
by Hong Wai Onn

Given the extensive list of challenges currently facing the world, some of which are food supply, energy, and the environment, there is a limited number of engineers readily available to address these challenges. So where could chemical engineering talent best be deployed?

One noteworthy option is the palm oil industry. This is an opportunity for chemical engineers for three main reasons. First, palm oil involves the kind of technologies that chemical engineers have a solid understanding in, especially in terms of heat transfer, thermodynamics, mass transfer, and separation processes. Second, the Food and Agriculture Organization of the United Nations projects world population to reach 9.1bn people – an increase of 33% – between 2009 and 2050.[1] This means that demand for food, including vegetable oils, is expected to continue to grow accordingly. Third, palm oil is by far the most productive vegetable crop, outdoing all others in terms of average oil yield per hectare (*see Figure 1*). Worldwide, palm oil is an important resource and the most-commonly used vegetable oil. According to the United States Department of Agriculture, palm oil accounts for about one-third of food use in 2018/19[2] and can be found in 50% of all supermarket products. The question is, therefore, how can chemical engineers contribute to producing enough palm oil to satisfy the global demand, and make it a better industry?

Can the World Produce Enough Palm Oil to Satisfy Global Demand?

Indonesia and Malaysia account for approximately 84% of the world's total production of palm oil. However, due to the combination of existing and expected new moratoriums, along with palm oil buyers' "no deforestation, no peatland, no exploitation" policies, land expansion could be at the bottom of the list of priorities for both countries' palm oil industry. Given this land scarcity, it is pivotal to explore how new technology can further improve palm oil milling operations and yields.



While it is justified to claim that there were many incremental improvements and changes in various unit operations in the palm oil mills, they have not changed significantly since the publication of the Mongana report in the 1950s. The palm oil mills still rely heavily on sterilisers, threshers, digesters, screw presses, clarifier tanks and centrifuges or separators. Large quantities of steam and water are required to sterilise fresh fruit bunches (FFBs), digest palm fruits, and dilute press liquor for oil recovery in the clarification process. Oil extraction rate (OER) is the key performance indicator for palm oil mills. OER is a ratio of crude palm oil produced to FFB processed. As chemical engineers, let's ask ourselves the question: can the existing thermo-mechanical extraction process continue to remain as it is for the next 100 years, whilst still satisfying the growing demand for palm oil? If the answer is no, then we ought to rejuvenate our minds in a proactive and creative manner to assist the palm oil milling sector in improving output and bottom lines.

Where are we in palm oil milling?

In traditional palm oil milling, the FFBs are steam sterilised and digested before mechanically extracting the oil. The main objective of these processes is to break up the oil-bearing cells to facilitate better oil release. The traditional thermo-mechanical extraction process is, however, reaching its limit, which explains why the oil extraction rate has remained stagnant for many years, with a gentle declining trend in recent years (*see Figure 2*). Biotechnology, i.e. enzymatic technology can help oil mill operators overcome this problem, due to the ability of enzymes to effectively break down plant cell walls. Hence, enzymes could be the next big operational breakthrough for the palm oil milling sector.

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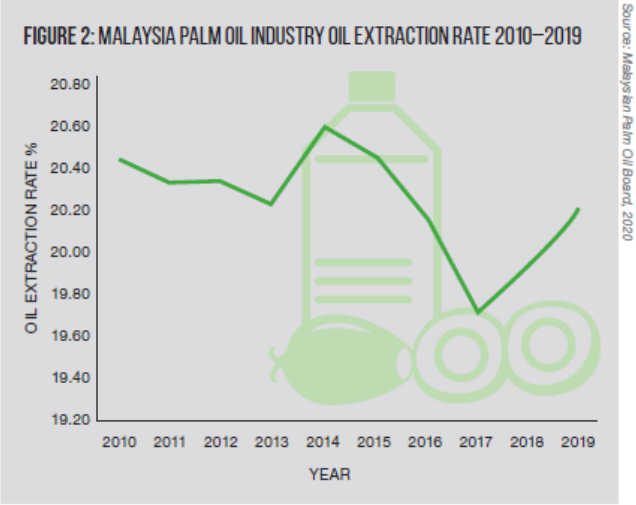
From Page 20



Chemical engineers will know that enzymes are proteins that act as catalysts. They are highly specific, allowing specific reactions and acting on specific substrates. They are fully biodegradable, breaking down into harmless amino acids. And while enzymes may be new to the palm oil milling industry, the technology has been proven and well established in many other industries for a long time. This entails industries such as chemical synthesis, where enzymes have been used to replace chemical catalysts in synthetic processes. Recently, enzyme use has gained momentum in the chemical and pharmaceutical industries, and it is an important tool for medicinal, process and polymer chemists to develop efficient and highly attractive organic synthetic processes on an industrial scale. For example, Pfizer has developed a biocatalytic process to boost the efficiency of its production of the epilepsy drug Pregabalin.[3]

Enzymatic palm oil extraction process: A boon

Applied to the palm oil industry, enzymes could aid several upstream as well as downstream processes and become a game-changing technology that benefits palm oil mills and addresses many of the challenges the industry faces today, particularly in the palm oil extraction process.

Novozymes is currently trialing its enzyme and claims to have several ongoing enzymatic palm oil extraction trials as well as full-scale mill operations across Indonesia and Malaysia,[4] including with Sime Darby Plantation, the world's largest palm oil plantation company by planted area.[5]

This enzymatic process can be adopted via just a few steps and reasonable capital investment and with significant improvement to the bottom line.[4] Applied under the right conditions, the enzymes soften and break down the cellulose and hemicellulose matrices in the oil-bearing cell walls, thereby enabling easier oil release. One of the full-scale mill operations with enzymatic palm oil extraction process is recording 4% oil yield increases.[5] If we assumed the entire Malaysian palm oil industry adopted enzymatic technology, an extra 0.8m t of crude palm oil (CPO) could be obtained with the same amount of land, which in turn would feed the entire population of Malaysia (31.6m) for nearly 11 months.[6]

Sustainability-wise, enzymatic palm oil extraction processes could enable a 9% reduction in greenhouse gas emissions, alongside 4% lower nature occupation impact, per tonne of crude palm oil produced, according to a peer-reviewed life cycle assessment study.[7]

It is also important to note that there is no evidence on the change of CPO quality following the adoption of the enzymatic palm oil extraction process. Results obtained from full-scale mill operations indicate that enzymatic technology does not affect the quality of the oil extracted and that the CPO quality is not significantly different from conventional milling operation.

Feedstock for biodiesel production – waste to wealth

As a chemical engineer, I believe we need more renewable energy sources instead of solely relying fossil fuels like diesoline. I always imagine that one day in the future, oil (crude oil or fuel) would be harvested not under but above the ground. This means we could produce biodiesel to replace fossil-based diesel. Molecularly, biodiesel in general refers to fatty acids methyl ester that is produced from vegetable or animal oils and fats through transesterification and esterification processes with methanol.

However, the biodiesel industry has been under pressure due to rising concerns about feedstock availability and pricing. For these reasons, cheap, low-quality, and non-food oils like palm sludge oil generated from palm oil mills have long been considered for biodiesel feedstock. Instead of being left in the effluent treatment pond, it could become an attractive natural source for biodiesel. This perhaps also explains why palm sludge oil is classified as material that is eligible for double accounting of greenhouse gas savings under the Renewable Energy Directive by International Sustainability and Carbon Certification.[8]

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From Page 21

However, one of the problems with traditional biodiesel production with chemical catalysts is the difficulty for this process to work with high free fatty acid feedstocks like palm sludge oil. A complex two-stage chemical process called esterification followed by a transesterification system is needed for biodiesel production. In addition, the chemical biodiesel process requires not only costly refining or pre-treatment of high free fatty acid feedstocks, but also harsh chemicals and high energy input, all adding to the capital and operational expenses, as well as an increase in carbon footprint.

Marc Kellens, Group Technical Director at Desmet Ballestra, once said: "In conventional plants, 80–85% of the costs of biodiesel are linked to feedstock cost. So the more you are able to convert a cheaper feedstock into biodiesel, the more profitable the business is."[9]

Enzymatic biodiesel production

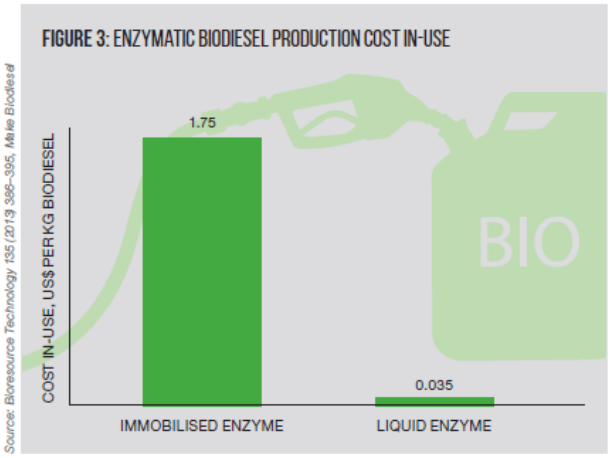
Enzymatic technology, on the other hand, with a specifically developed lipase enzyme enables biodiesel producers to produce high-quality biodiesel from oils with any range of free fatty acid. The enzymatic process is a combined hydrolysis and esterification reaction as both glycerides and free fatty acid are converted into methyl esters by using water and methanol. Water can be added to an enzymatic system as free water, with wet methanol, or it can be produced in situ by esterification of free fatty acids. A two-phase system with a heavy phase consisting of water, glycerine, and methanol, and a light phase consisting of glycerides, free fatty acid, and fatty acid methyl esters with some dissolved methanol as well will be produced at the end of the process. To meet the biodiesel specifications of the American Society for Testing and Materials standard and the European standard, polishing of free fatty acids can be done either by caustic neutralisation, enzymatic esterification or resin esterification.

This biodiesel product, either in pure form or blended with fossil-based diesel, could be used as a substitute for conventional fossil-based diesel-driven vehicles as well as diesel generators within the palm oil plantation. This is what I meant by one day in future oil (fuel) would be harvested not under but above the ground. The dawn of the new oil industry!

This is how relevant biochemical is to enzymatic biodiesel operation. This is nothing new to chemical engineers; it is just the basics of design, build, and advancement of unit processes that involve biological catalysts. And we just need to roll up our sleeves and get started.

Safer and sustainable operation with a biological solution

Enzymatic biodiesel production has been considered a promising alternative since the early 90s, in the scientific community. Historically, the high cost of enzymes has outweighed any benefits they might offer, such as their ability to convert low-quality, high free fatty acid feedstocks, savings on energy consumption, and coproduction of technical-grade glycerine. Nonetheless, the hurdle of making the process economically viable on a commercial scale has been overcome lately, especially with the major breakthrough of using liquid enzyme instead of immobilised enzyme. The cost for using liquid enzyme is approximately 50-fold lower than the immobilised enzyme (*see Figure 3*).



In recent years, many commercial biodiesel plants have been operating using enzymatic technology worldwide, particularly in the US and India. For example, Seaboard Energy Missouri (formerly known as HPB-St Joe Biodiesel), Aemetis, and Viesel Fuel.[10, 11, 12, 13] Most of the enzymatic plants are operating at the scale of around 100,000 t/y of biodiesel, which is comparable with conventional processing facilities.

As chemical engineers, we know that process safety is paramount. So is this biotechnology safe for industry? In a word, yes. In fact, enzymatic technology not only enables feedstock flexibility in biodiesel production, but also provides a safer and sustainable operation. The enzyme process eliminates the need for sodium methoxide, one of the most hazardous chemicals in traditional biodiesel plants. Elimination of such a hazardous chemical does not generate toxic components as in some chemical biodiesel processes. In addition, the organic nature of enzymes and their mild process conditions provide greater protection for both personnel and the environment, all adding to safer and sustainable biodiesel production.

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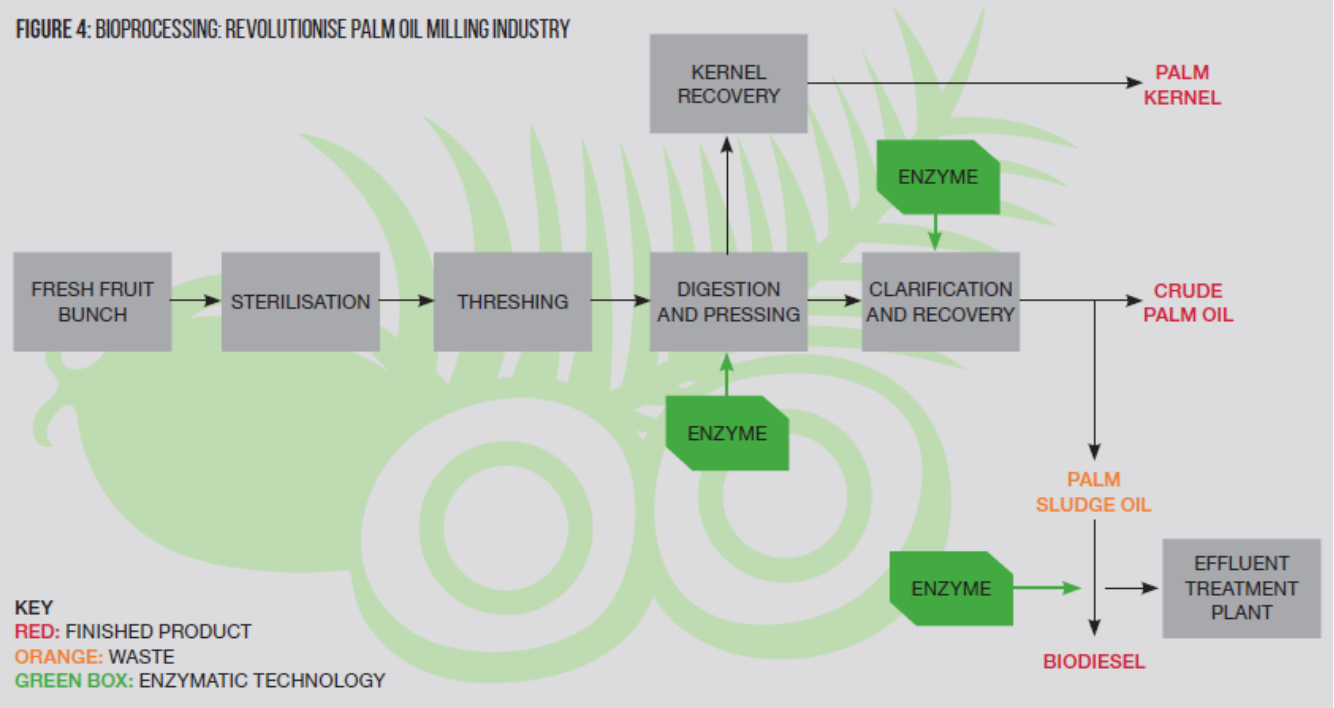
From Page 22



The way forward

The enzymatic oil extraction process is a proven technology for a more efficient and environmentally-friendly palm oil milling process going forward. The enzymatic biodiesel production on the other hand enables palm oil producers to process waste into wealth, a fuel source. The future for green biotechnology looks bright, and it is not difficult to imagine that in the next decade the palm oil industry will have been revolutionised with efficient and sustainable enzymatic processes. Hence, we as chemical engineers should rethink "tomorrow" and seriously consider enzymatic technology as a key component on the journey towards a better and brighter future. We should advocate the widespread use of such beneficial technologies, through awareness campaigns organised by the likes of the Malaysian Palm Oil Board, and increase knowledge sharing.

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