Introduction to the Palm Oil Industry

Palm Oil Processing Special Interest Group

Hong Wai Onn
POPSIG was formed on 3rd August 2015 in Kuala Lumpur, Malaysia to provide a forum for the exchange of ideas, the sharing of experiences and encouraging innovation in the palm oil processing industry.

It is not limited to traditional areas of milling, refining or oleochemicals. It includes new areas such as nutraceuticals, biogas and energy, biomass, biofuels and bio-based chemicals.

Processing in the palm oil industry encompasses all the four key challenges in Chemical Engineering Matters viz energy, food & drink, health & well being and water. The approach to improving the quality of life through the use palm oil has to be done safely and sustainably.
Introduction to the Palm Oil Industry

By
Hong Wai Onn CEng MIChemE
Palm Oil Processing Special Interest Group
Palm Oil at a Glance
The Palm Oil Supply Chain
What will be covered …

- The importance of palm oil
- Milling
- Refining
- Oleochemicals
- Bulking Installations
- Sources of information
- NKEA and the 8 EPPs in Malaysia
- The role of a chemical engineer
- Key players
Malaysia is celebrating 100 years of palm oil this year, as the first oil palm was grown in 1917.
Some Key Numbers 2016 for Malaysia

- 5.7 million hectares of land (17% of land mass)
- 17 million tonnes of palm oil & 2 million tonnes of palm kernel oil
- 8% of world’s oil & fat production
- Export revenue RM 41 billion (5.3%, #4)
- 600,000 people employed directly
Oil Palm Plantation
Process Flow for Milling

Slide 10
Palm Oil Mill
Process Flow for Refining
Palm Oil Refinery
Process Flow for Fractionation
Fractionated Palm Oil Products

- 100% Palm Oil
  - IV 52
  - 15% Palm Stearin
    - IV 36
  - 85% Palm Olein
    - IV 56
  - Frying Oil
    - 45% Soft PMF
      - IV 46
    - 40% Super Olein
      - IV >64
      - Salad Oil
    - 15% Hard PMF
      - IV 35
      - to CBE
    - 30% Mid Olein
      - IV 53
    - 20% Mid Olein
      - IV 60
    - 20% Top Olein
      - IV >67
      - Very cold stable salad oil
Activity 1

2 minutes

Enter into the question section
some edible products
made from palm oil
Edible Palm Oil Products ...
Palm Oil Derivatives Flowchart

NATURAL OIL & FRACTIONS
(Palm Oil, Palm Stearin, PKO, PFAD)

GLYCERINE

GLYCEROL ESTERS
(GMO, GMS etc)

METHYL ESTERS

METHYL ESTER SULPHONATES (MES)

FATTY ACIDS

FATTY ALCOHOLS

FATTY AMINES

APG

AMINE OXIDES

QUATERNARY SURFACTANTS
(Fabric Conditioners)

ESTERS
(IPP, IPM, EGDS, etc)

ALKANOLAMIDES (CMEA, CDEA)

FATTY ISETHIONATES
(SCI)

SOAP

BETAINES
(CAPB)

QUATERNARY SURFACTANTS
(CTAC)

ALCOHOL SULPHATES (SLS)

ALCOHOL ETHOXYLATES
(AEO, NI)

ETHER SULPHATES
(SLES, ALES)
Fatty Acids & Fatty Alcohol Plants
Activity 2

2 minutes

Enter into the question section some end consumer products containing oleochemicals and their derivatives
## End Consumer products ...

<table>
<thead>
<tr>
<th>Product</th>
<th>Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soap noodles</td>
<td><img src="image" alt="Soap noodles" /></td>
</tr>
<tr>
<td>Sodium lauryl sulfate</td>
<td><img src="image" alt="Sodium lauryl sulfate" /></td>
</tr>
<tr>
<td>Stearic Acid</td>
<td><img src="image" alt="Stearic Acid" /></td>
</tr>
<tr>
<td>Esters</td>
<td><img src="image" alt="Esters" /></td>
</tr>
<tr>
<td>Glycerin, Isopropyl Myristate</td>
<td><img src="image" alt="Glycerin, Isopropyl Myristate" /></td>
</tr>
<tr>
<td>Methyl Ester Sulfonate</td>
<td><img src="image" alt="Methyl Ester Sulfonate" /></td>
</tr>
<tr>
<td>Cetyl palmitate, isopropyl myristate, sorbitan monostearate, stearyl alcohol</td>
<td><img src="image" alt="Cetyl palmitate, isopropyl myristate, sorbitan monostearate, stearyl alcohol" /></td>
</tr>
<tr>
<td>Amide as slip agent</td>
<td><img src="image" alt="Amide as slip agent" /></td>
</tr>
<tr>
<td>Tocotrienols</td>
<td><img src="image" alt="Tocotrienols" /></td>
</tr>
</tbody>
</table>
Bulking Installations – Key for Exports
## Key Organizations

<table>
<thead>
<tr>
<th>Name</th>
<th>Full name</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPOA</td>
<td>Malaysian Palm Oil Association (Growers)</td>
</tr>
<tr>
<td>MPOB</td>
<td>Malaysian Palm Oil Board (Licensing/R&amp;D)</td>
</tr>
<tr>
<td>MPOC</td>
<td>Malaysian Palm Oil Council (Promotion)</td>
</tr>
<tr>
<td>PORAM</td>
<td>Palm Oil Refiners Association of Malaysia</td>
</tr>
<tr>
<td>AOMG</td>
<td>ASEAN Oleochemical Manufacturers Group</td>
</tr>
<tr>
<td>MEOMA</td>
<td>Malaysian Edible Oil Manufacturers Association</td>
</tr>
<tr>
<td>MBA</td>
<td>Malaysian Biodiesel Association</td>
</tr>
<tr>
<td>RSPO</td>
<td>Roundtable on Sustainable Palm Oil</td>
</tr>
<tr>
<td>MPOCC</td>
<td>Malaysian Palm Oil Certification Council</td>
</tr>
<tr>
<td>CPOPC</td>
<td>Council of Palm Oil Producing Countries</td>
</tr>
</tbody>
</table>
NKEA in Malaysia

National Key Economic Areas (NKEA)

2) Palm oil and related products
EPP in Malaysia

Entry Point Project (EPP)

Upstream productivity
- EPP 4: Increasing the oil extraction rate
- EPP 5: Developing biogas at palm oil mills

Downstream expansion and sustainability
- EPP 6: Developing oleo derivatives
- EPP 7: Commercializing second generation biofuels
- EPP 8: Expediting growth in food- and health-based downstream segments
## List of companies under EPP 6 Q1 2014

<table>
<thead>
<tr>
<th>Companies/Projects - Products</th>
<th>Total investment</th>
<th>Total grant committed*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EPP 6 Product commercialisation projects</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICM Specialty - Surfactant &amp; Glycerol Derivatives</td>
<td>134.40</td>
<td>19.01</td>
</tr>
<tr>
<td>IOI Esterchem - Glycerol Derivatives and Bio-lubricants</td>
<td>130.00</td>
<td>43.60</td>
</tr>
<tr>
<td>KLK - Palm Oleo Klang - Specialty Esters</td>
<td>16.40</td>
<td>5.25</td>
</tr>
<tr>
<td>KLK - Oleomas - Fatty Alcohols/Acids &amp; MES Integrated Complex</td>
<td>480.10</td>
<td>107.90</td>
</tr>
<tr>
<td>Ancom - MSMA Herbicides Manufacturing Plant Expansion</td>
<td>9.77</td>
<td>0.09</td>
</tr>
<tr>
<td>Emery P1 - Plastic Additives and Bio-Lubricants</td>
<td>136.50</td>
<td>7.72</td>
</tr>
<tr>
<td>Emery P2 - Surfactant (Specialty Esters)</td>
<td>86.7</td>
<td>11.20</td>
</tr>
<tr>
<td>Emery P3 - Surfactant (Sulphates)</td>
<td>187.52</td>
<td>12.80</td>
</tr>
<tr>
<td>Emery P4 - Expansion of ME Fractionation &amp; Tank Farms</td>
<td>69.89</td>
<td>3.89</td>
</tr>
<tr>
<td>Carotino - Expansion of MCT Plant</td>
<td>10.00</td>
<td>0.80</td>
</tr>
<tr>
<td>Unioleon - Oleo Derivatives for Food Application</td>
<td>91.85</td>
<td>11.21</td>
</tr>
<tr>
<td>Company A - Production of Methyl Ester, Glycerine, and crude Carotene</td>
<td>100.00</td>
<td>1.10</td>
</tr>
<tr>
<td>Company B - Short Path Distillation Extension for Glycerol Derivatives</td>
<td>17.00</td>
<td>5.59</td>
</tr>
</tbody>
</table>

Source: PEMANDU
Chemical Engineering Matters

The role of chemical engineers in the palm oil industry and society
Chemical Engineering Matters

• Outlines the scope, application and implications for chemical engineering in activities across the four challenge areas (Water, Energy, Food and nutrition, and Health and wellbeing) where chemical engineers create, maintain and improve quality of life, now and in the future.

The Role of a Chemical Engineer

Quality of life
- More sustainable
- Safer

 Appropriately-educaded and trained

Fundamental chemical engineering science
- Physics
- Chemistry
- Maths
- Biology

Productive exchange with R&D

Collaborative, multidisciplinary research and development
The Role of a Chemical Engineer

Sustainability
- Resourcing and manufacturing
- Process safety
- Education, training and research
- Chemical engineering fundamentals: systems
- Multidisciplinary and collaborative working
- The ‘bio’ dimension

Quality of life
- Energy
- Food and nutrition
- Health and wellbeing
- Water

Key challenges
The Role of a Chemical Engineer

Competence

- Application of knowledge
- Wider implications
- Transferable skills
## Application of Knowledge

<table>
<thead>
<tr>
<th>Item</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process technologies</td>
<td>Distillation, crystallisation, filtration</td>
</tr>
<tr>
<td>Safety systems</td>
<td>Management of change, HAZOP</td>
</tr>
<tr>
<td>Laws of conservation</td>
<td>Multiple effect evaporation</td>
</tr>
<tr>
<td>Mathematical modeling</td>
<td>Spray crystallisation, catalysed reactions</td>
</tr>
<tr>
<td>Underlying chemistry</td>
<td>Hydrolysis, esterification, hydrogenation</td>
</tr>
<tr>
<td>Systems analysis</td>
<td>Trouble shooting, control of processes</td>
</tr>
<tr>
<td>Chemical thermodynamics</td>
<td>Increasing splitting degree in a hydrolyzer</td>
</tr>
<tr>
<td>Economic evaluation</td>
<td>Plant debottlenecking, cost savings</td>
</tr>
</tbody>
</table>
## Technical Areas

<table>
<thead>
<tr>
<th>Process plant operation</th>
<th>Legislation, regulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer application</td>
<td>Development of products, services</td>
</tr>
<tr>
<td>Project management, administration</td>
<td>Teaching, managing, training</td>
</tr>
<tr>
<td>Instrumentation &amp; control</td>
<td>Quality &amp; assurance</td>
</tr>
<tr>
<td>Technical / economic evaluation</td>
<td>R&amp;D</td>
</tr>
<tr>
<td>Economic accountancy, cost estimation</td>
<td>Technical sales, marketing, contracts</td>
</tr>
<tr>
<td>Health, safety, risk aspects</td>
<td>Design of process, plant &amp; equipment</td>
</tr>
<tr>
<td>Sustainability &amp; environmental aspects</td>
<td></td>
</tr>
</tbody>
</table>
## Wider Implications

<table>
<thead>
<tr>
<th>Item</th>
<th>Examples</th>
</tr>
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<tbody>
<tr>
<td>Health, hazard and safety aspects</td>
<td>Opportunity to improve process safety</td>
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<td><strong>Registration, Evaluation, Authorisation and Restriction of Chemical substances (EU)</strong></td>
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<td>Sustainability aspects</td>
<td>Clean Development Mechanism (POME) &amp; National Biomass Strategy 2020</td>
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<td>Roundtable on Sustainable Palm Oil (RSPO)</td>
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<td>Commercial and economic aspects</td>
<td>Fluctuating palm oil &amp; palm kernel prices</td>
</tr>
<tr>
<td></td>
<td><strong>NKEA : Palm Oil as a Growth Engine in the Tenth Malaysia Plan (2011-2021)</strong></td>
</tr>
</tbody>
</table>
National Biomass Strategy

- It aims to assess how Malaysia can gain more revenue from its palm oil industry through utilisation of the associated biomass.
Palm oil can power the world

Powering the world

The palm oil sector can produce more energy than what most countries need.

We estimate that palm oil could provide more than 5% of the world's energy demand. This is due to its high energy density and the fact that it can be grown on waste land, which reduces the pressure on food production.

In addition, palm oil is a renewable source of energy. It can be used as a biofuel, which can replace fossil fuels. This is particularly important as we move towards a sustainable energy economy.

Toward a Sustainable Energy Economy – The Role of Palm

Ian L. Halsall, Ph.D., Consultant

Abstract

This paper reviews the factors which affect the palm industry's role in the world energy economy. Currently, palm oil is the world's largest producer of biofuel, but if the world's palm oil and palm biomass by-product were to be used as fuel, then the annual energy supply would be 7,311 exajoules – more than most countries' requirements. Alternatives are evaluated, as are social issues.

Keywords

Palm, Renewable Fuel, Palm Biomass, Energy Economy, Sustainable Energy

1. Introduction

Today the worldwide palm oil industry is expanding, with an annual production of some 42 million tonnes (as of 2010). Most of this gets consumed in food, biofuel, and cosmetics, but in recent years palm oil has already entered the world's fuel market too.

To give an idea of the palm industry's potential for energy, these figures are scalable. If all the palm oil produced were consumed as fuel, this would produce 1.64 terajoules (m a = 10^12) of energy per year. On top of that, there is the palm industry's by-product (palm biomass) which, after processing, would give an extra 0.57 terajoules, bringing the total for palm to 7.31 terajoules annually.

To give these numbers some perspective: 42 million tonnes of oil per year equals 640,000 barrels per day. That is equivalent to 50% of the UK's current oil consumption of 1.710,000 barrels per day (crude oil and palm oil have comparable energy densities). An alternative perspective is that 640,000 barrels per day is more than the total daily oil consumption of Argentina. Also, 640,000 barrels per day is greater than the oil consumption of 182 different countries (208 being the total number of countries in the world).

The above figures refer to palm oil production and fuel oil consumption. If we include the total palm biomass too, then the potential increases considerably. This is because the quantities of energy from non-oil palm biomass equal around 3.57 times the energy value of palm oil alone. When we sum up both the palm oil and the non-oil biomass, we get the above-mentioned figure of 7.31 terajoules per year. That means the palm oil industry could supply more than the total energy consumption of many countries. For example, if we focus on electricity consumption, then 7,311 exajoules of fuel value equals to 2.03 billion kWh per year. Taking a typical power station efficiency of 32%, the figure for available electricity is then 669 million kWh per year. For comparison only, a few countries consume more than this (such as USA, China, Russia, Japan and India), whereas there are another 181 countries in the world, where such a number would be more than their national requirement (on an individual country basis). In fact, it would be more than several smaller countries combined. All in all, the potential is large. How much of this potential finally gets realized, depends on a number of factors...

Email: I.L. Halsall@london.edu

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Waste is profit

Profits from oil palm waste

All Cosmos uses bio-technology to improve fertiliser quality

Biomass products gain demand

They promote efficiency and are environmentally friendly
## Wider Implications

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<tr>
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<th>Examples</th>
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<td><strong>NKEA : Palm Oil as a Growth Engine in the Tenth Malaysia Plan (2011-2021)</strong></td>
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</tbody>
</table>
Sustainable development

**RSPO**
Roundtable on Sustainable Palm Oil

**RSPO P & C**
8 principles, 39 criteria, 125 indicators

- Law & Regulation
- Economic/Financial Viability
- Best Agriculture Practice
- Transparency
- Environmental
- Social
- New Planting
- Continuous Improvement

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Slide 39
Stand on Palm Oil Production

- IChemE believes that chemical engineers play an important role in a current and future sustainable palm oil industry.

- IChemE supports the practice of certification of palm oil from the plantation through to final consumer products.

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Policy position: palm oil production

Palm oil is a widely used raw material and is found in many products from food, cosmetics and pharmaceuticals to biofuels, it has many applications. The high yield of palm oil per hectare, relatively low cost and versatility in use are attractive. It accounts for over 20% of global vegetable oil production. In 2013, around 88% of global palm oil was produced in Indonesia and Malaysia. This has supported economic development in this region.

In recent years there has been considerable concern regarding the sustainability aspects of the palm oil industry. The growth in palm oil production has led to deforestation, loss of habitat, negative impacts on rural and indigenous communities and air and water pollution. International concern about the sustainability of this industry has led to the establishment of different groups including the Roundtable for Sustainable Palm Oil (RSPO). Many companies that use palm oil in their products have made commitments to either reduce their consumption of palm oil or ensure that it comes from sustainable sources.

Upstream palm oil production (agriculture and milling) employs few, if any, chemical engineers. However, many chemical engineers work in downstream refining and industries such as petro-chemicals. The chemical engineering skillset can be applied in both upstream and downstream areas. This can influence good practice and improve sustainability through improved yield, energy efficiency, waste reduction, effluent treatment and reduction in water, land and air pollution.

IChemE believes that chemical engineers play an important role in a current and future sustainable palm oil industry. It is essential high standards of environmental protection, process safety and responsible production are implemented across the sector. IChemE supports the practice of certification of palm oil from the plantation through to final consumer products.

The principles that are the foundation to a sustainable industry are essential components of IChemE

http://www.icheme.org/~media/Documents/icheme/Media%20centre/Policy%20position%20statements/Policy%20position%20palm%20oil%20production.pdf

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Slide 40
Palm oil for well being (tocotrienols)

Tocotrienols, the lesser-known siblings of the vitamin E family, are fast emerging as a superior addition to the prevalent and more popularly used, tocopherols. Together, they provide a full range of antioxidant properties that are vital for good health.
## Transferable Skills

<table>
<thead>
<tr>
<th>Item</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Managing relationships</td>
<td>Developing supporting staff with low level of formal education</td>
</tr>
<tr>
<td>Leadership in a professional role</td>
<td>Lead peers from different backgrounds in project</td>
</tr>
<tr>
<td>Communicating ideas formally</td>
<td>Applying to be a Chartered Chemical Engineer</td>
</tr>
</tbody>
</table>
## The Role of a Chemical Engineer

### Commitment

<table>
<thead>
<tr>
<th>Item</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commitment to profession</td>
<td>Be active in IChemE &amp; your trade/technical association</td>
</tr>
<tr>
<td>Continuing professional development.</td>
<td>Do regular gap analysis</td>
</tr>
</tbody>
</table>
Typical Numbers …

<table>
<thead>
<tr>
<th>Item</th>
<th>Mill</th>
<th>Refinery</th>
<th>Oleochemical Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment, RM mil</td>
<td>55</td>
<td>85</td>
<td>125</td>
</tr>
<tr>
<td>Capacity, t/day</td>
<td>500</td>
<td>1000</td>
<td>400</td>
</tr>
<tr>
<td>No of employees</td>
<td>50</td>
<td>100</td>
<td>180</td>
</tr>
<tr>
<td>No. of Chemical Engineers</td>
<td>0.5</td>
<td>2</td>
<td>10</td>
</tr>
</tbody>
</table>
Activity 3

2 minutes

Enter into the question section some key players in the palm oil industry: Suppliers, Manufacturers, and Customers
## Key Players

<table>
<thead>
<tr>
<th>Suppliers</th>
<th>Manufacturers</th>
<th>Customers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item</td>
<td>Item</td>
<td>Item</td>
</tr>
<tr>
<td>Caustic Soda</td>
<td>CCM Mill</td>
<td>Sime Darby Soap noodles</td>
</tr>
<tr>
<td>Plant</td>
<td>Desmet Ballestra Refinery</td>
<td>Cargill Edible Oils</td>
</tr>
<tr>
<td>Methanol</td>
<td>Petronas Fatty Acids</td>
<td>IOI Oleo Edible Oils</td>
</tr>
<tr>
<td>Boiler</td>
<td>Boilermech Fatty Alcohol</td>
<td>Emery Oleo Fatty Acids</td>
</tr>
<tr>
<td>Mill</td>
<td>CBIP Esters</td>
<td>Nat Oleo Fatty Alcohol</td>
</tr>
<tr>
<td>Enzyme</td>
<td>Novozymes Biodiesel</td>
<td>Carotino Esters</td>
</tr>
<tr>
<td>Biogas plant</td>
<td>Kubota Biorefinery</td>
<td>Genting Biodiesel</td>
</tr>
</tbody>
</table>

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100 Years for Malaysian Palm Oil

- Can we continue to be the global technology leader in the processing of this Golden Crop?

- Big potential for us to transform the industry particularly in process engineering through science and innovation.
Conclusion

- Palm oil is the most widely-used vegetable oil in the world
- The oil palm tree is the most efficient oil crop in terms of land use
- Join the palm oil industry and be a leader
- Set your sights now on being a Chartered Chemical Engineer
Thank You
Next Evening Talk

Challenges in Biodiesel Business

on 10 April 2017

at Monash University Malaysia

by U.R. Unnithan, founder & CEO of SUMWIN Group