Fuel of the Future

Introducing the Latest Palm Biodiesel Technology to the World

For further enquiries, kindly contact:

LIPOCHEM (M) SDN BHD
(Co. No. 496524-U)

K.L. Office:
No.3-4, Jalan SP 2/1, Taman Serdang Perdana, 43300 Seri Kembangan, Selangor, Malaysia.
Tel: 603-8943 2477 / 603-8943 2488 Fax: 603-8943 2499 Email: lipochem@streamyx.com

MPOB

Director General, Malaysian Palm Oil Board (MPOB)
P.O. Box 10620, 50720 Kuala Lumpur, Malaysia.
Tel: 603-8925 9155, 603-8925 9775 Fax: 603-8925 9446 Website: http://mpob.gov.my

MPOB LIPOCHEM (M) SDN BHD

Working together towards a cleaner and greener future

Introduction to Palm **Biodiesel**

It is largely accepted that conventional sources of fuel and energy are being rapidly depleted and there is a global search for sustainable sources of alternative renewable fuel. One of the most exciting development is fatty acid methyl esters, popularly known as Biodiesel.

Biodiesel is an alternative renewable fuel that has been hailed as one of the biggest technology breakthroughs in the Oils and Fats industry.
It is one of the most viable substitutes for petroleum diesel fuel and is manufactured from vegetable oils, animal fats or recycled greases combined with alcohol (ethanol or methanol) in the transesterification process.

Biodiesel has a major advantage over petroleum diesel in that it is derived from renewable sources and is environmentally friendly. Therefore, fewer green house gases such as carbon dioxide are released into the atmosphere. In several countries, a combination of legislation and tax breaks favor the rising production and consumption of Biodiesel. In the US, Biodiesel is considered to be the lowest cost-strategy in complying with state and federal regulations on emission as it does not require major engine modifications.

As the world's largest Palm Oil producer and exporter, Malaysia is now looked upon as the pioneer of a new and exciting Palm Biodiesel Industry.
The benefits of Biodiesel encompassing economical and environmental components are well in line with the Malaysian government's efforts in developing the Fifth Fuel Policy for the country.

MPOB has always been striving for higher standards and improving the technology through development work with public and private sectors.
By collaborating with an established technology provider such as LIPOCHEM to commercially produce Palm Biodiesel as a fuel as well as exporting the home grown technology for efficient processing, MPOB has set an industry precedent. A pilot project that MPOB initiated has already revealed exciting prospects.

What is Palm **Biodiesel?**

Palm Biodiesel is an alternative fuel derived from Palm Oil and can be used in compression ignition engines i.e. diesel engines without any modifications. It refers to methyl esters derived from Palm Oil through a process known as "transesterification".

Biodiesel has been recognised and accepted as an alternative and renewable source of energy which is environmentally friendly. Biodiesel is degradable, non toxic and can be used as transportation fuel in most public transportation system. It can be used in pure form but is often blended with regular diesel.

Palm Biodiesel has been systematically and exhaustively evaluated as diesel fuel substitute since 1983. These include laboratory evaluation, stationary engine testing and field trials on a large number of vehicles, including taxis, trucks, trains, passenger cars and buses. MPOB, in collaboration with LIPOCHEM, pioneered the development of Palm Biodiesel production technologies and scaled up the process for commercial use. The commercial plant will be able to produce Biodiesel that meets international standards, e.g. EN 14214.

Quality of feedstock required (as per PORAM specification)

Specification	Unit	RBD/NBD Palm Oil	RBD/NBD Palm Olein
Free Fatty Acid (as palmitic)	%	0.1 (max.)	0.1 (max.)
Moisture & Impurities	%	0.1 (max.)	0.1 (max.)
Iodin Value (Wijs)		50 to 55	56 (min.)
Melting Point (AOCS Cc3-25)	^{0}C	33 to 39	24
Colour (5¼" Lovibond cell)	Red	3 (max.)	3 (max.)

Quality of final product, Palm Biodiesel

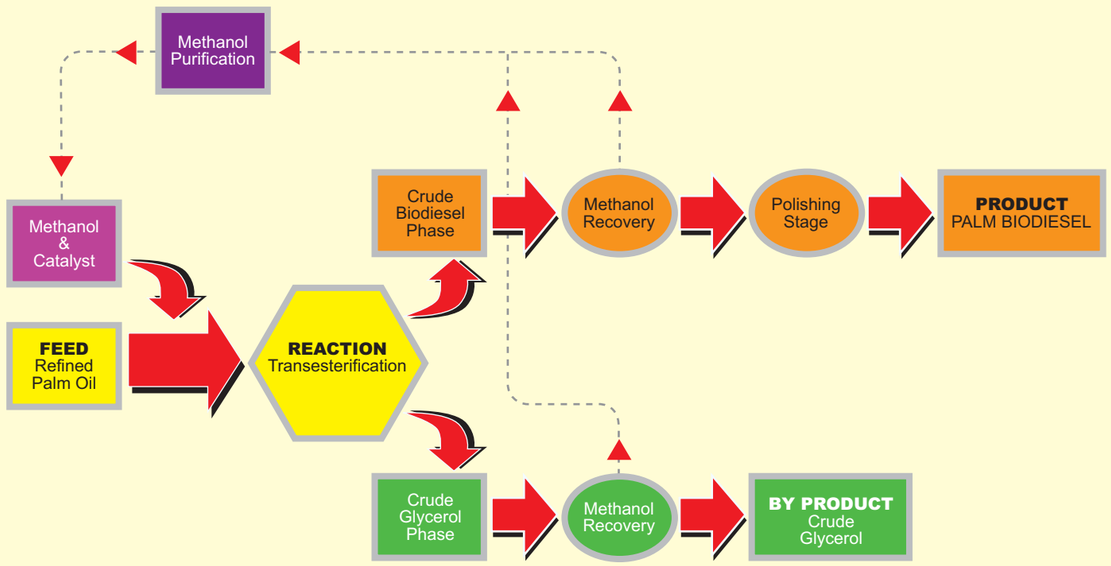
Specification	Unit	Limits
Flash Point	^{0}C	120 (min.)
Water	mg/kg	500 (max.)
Methanol	% mass	0.20 (max.)
Ester Content	% mass	96.5 (min.)
Free Glycerol	% mass	0.02 (max.)
Total Glycerol	% mass	0.25 (max.)

Product Yield : 96.5% min
By Product, Glycerol : 80% max. purity

The Palm Biodiesel Process

Refined Bleached and Deodorised (RBD) Palm Oil/Olein in the presence of excess methanol and alkaline catalyst is heated to the reaction temperature and passes through multi stage continuous reactors. These reactors are used in a series to maximize the reaction conversion. Glycerol is removed after each reactor. The removal of Glycerol is important to push forward the reaction to achieve a higher conversion. After the reaction is completed, the excess methanol is recovered by flashing through the flash vessels and distilled by using methanol purification column with structured packing. The recovered methanol is then recycled and reused in the reaction process. The crude Biodiesel is washed using hot water and separated by centrifugal separation. It is then dried under vacuum to achieve low moisture content of the final product and sent to storage tanks. The glycerol is flashed to recover methanol and sent to storage tanks as crude glycerol.

Understanding **the Process**



A Brief Look Into the Development of **Palm Biodiesel Technology**

Malaysian Palm Oil Board (MPOB) has been very innovative and forward looking in developing the technology of Palm Biodiesel. The efforts of MPOB include:

- **Installing two 3000 tonnes/year capacity plants:**
  - MPOB HQ, BB Bangi, 1985, one of the earliest small scale continuous plants and the first using palm oil as feedstock, refurbished by LIPOCHEM in 2003.
  - A Commercial Company, built by LIPOCHEM in 2002.
- **Biodiesel produced in both plants is being sold in Europe.**
- **In collaboration with MPOB, LIPOCHEM has designed a 60 000 tonnes/ year capacity plant.**
- **A number of improvements have been made to the existing plant designs.**

Responding to an awakening interest from the Oils and Fats industry during the 1980s, MPOB initiated extensive research on Palm Methyl Esters, Palm Biodiesel and its products. The research resulted in the development of several technological processes to convert Palm Oil and its products into methyl esters for application as Biodiesel. Methyl esters from Palm Oil produced by MPOB have similar properties to petroleum diesel. It can be used directly as fuel in unmodified diesel engines as well as a diesel improver. In recent years, further research paid off when Palm Biodiesel with low "pour" point was produced to match requirements for year long usage. With this, Palm Biodiesel can be utilised in countries with different climates.

Exhaustive tests on the viability of Palm Biodiesel as an alternative fuel have been conducted, covering stationary engine testing and field trials with 36 Mercedes Benz engines mounted onto passenger busses. The success of the tests strongly supports the viability factor of the Biodiesel technology.

LIPOCHEM, with years of industrial engineering experience in designing palm oil refineries, translated all these R&D findings into commercial applications. Based on the experience of building the small scale (3000 tonnes/year capacity) commercial Palm Biodiesel plant and in refurbishing the MPOB Palm Biodiesel pilot plant, LIPOCHEM's team of innovative engineers took up the challenge to scale up the existing pilot plant to a large commercial plant with 60,000 tonnes/year capacity. Now, the technology is ready to be used for the production of Palm Biodiesel for the global Biodiesel market.

The Commitment of the Malaysian Government towards the Palm **Biofuel** Program

The Malaysian government is fully committed to a clean healthy environment and at the same time has the well being of the Palm Oil industry at heart. The commitment can be seen from the various programmes relating to Palm Biofuels that have been implemented or are being initiated. These included the Palm Oil burning programme introduced in 2001 and the possibility of introducing new legislation to make the use of Palm Biofuel mandatory. The proposed Malaysian Biofuel Policy will help in the development of the Malaysian Biofuel industry.

Fuel Properties of Normal and Low Pour Point **Palm Biodiesel**

Property	Unit	Normal	Low Pour Point	EN 14214	ASTM D6751
Ester Content	% mass	98.5	98.0 - 99.5	96.5 (min.)	-
Density at 15 C	kg/L	0.8783	0.87 - 0.89	0.86 - 0.90	-
Viscosity at 40 C	cSt	4.415	4 - 5	3.5 - 5.0	1.9 - 6.0
Flash Point	^{0}C	182	150 - 200	120 (min.)	130 (min.)
Cloud Point	^{0}C	15.2	-18 - 0	-	Report
Pour Point	^{0}C	15	-21 - 0	-	-
Cold Filter Plugging Point	^{0}C	15	-18 - 3	-	-
Sulfur Content	% mass	<0.001	<0.001	0.001 (max.)	0.0015 (min.) (Grade S15) 0.05 (min.) (Grade S500)
Carbon Residue (on 10% distillation residue)	% mass	0.02	0.02 to 0.03	0.3 (max.)	0.05 (max.)
Acid Value	mg KOH/g	0.08	<0.3	0.5 (max.)	0.8 (max.)
Sulfated Ash Content	% mass	<0.01	<0.01	0.02 (max.)	0.02 (max.)
Basic Sendiment and Water	% mass	<0.05	<0.05	0.05 (max.)	0.05 (max.)
Cetane Number	-	58.3	53.0 - 59.0	51 (min.)	47 (min.)
Copper Strip Corrosion (3h at 50 ^{0}C)	Rating	1a	1a	1	3 (max.)
Iodine Value	-	52	56 to 83	120 (max.)	-
Content of Linolenic Acid Methyl Esters	% mass	<0.5	<0.5	12 (max.)	-
Content of Polyunsaturated Fatty Acid Methyl esters (more than 3 double bonds)	% mass	<0.1	<0.1	1 (max.)	-
Methanol Content	% mass	<0.2	<0.2	0.2 (max.)	-
Monoglycerides	% mass	<0.8	<0.8	0.8 (max.)	-
Diglycerides	% mass	<0.2	<0.2	0.2 (max.)	-
Triglycerides	% mass	<0.2	<0.2	0.2 (max.)	-
Free Glycerol	% mass	<0.02	<0.02	0.02 (max.)	0.02 (max.)
Total Glycerol	% mass	<0.25	<0.25	0.25 (max.)	0.24 (max.)

Notes :
ASTM D6751 : American Standard Specification for Biodiesel Fuel (B100) Blend Stock for Distillate Fuels
EN14214 : European Standard for Biodiesel

Why Choose **Palm Biodiesel**

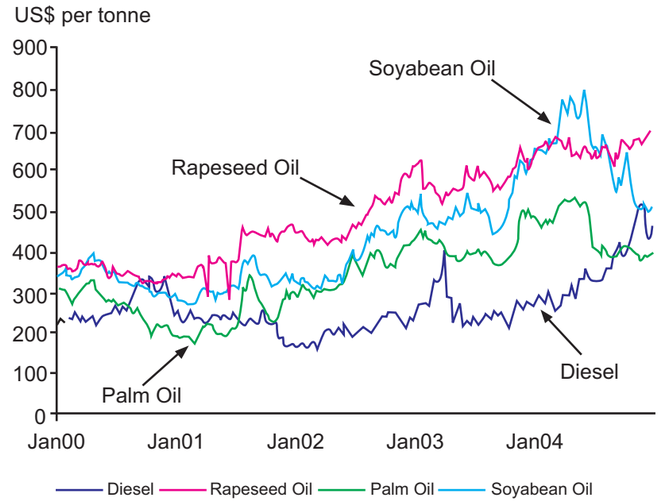
Palm Oil is the most productive oil bearing plant species. The yield of Palm Oil per unit area is 5 and 10 times higher than rapeseed and soy bean respectively. Considering the comparative yields of various oil-bearing crops, Palm Oil is clearly the most efficiently-produced in the world today.

When the global market increases its focus on vegetable oil as renewable fuel, Palm Oil will inevitably stand out. The yield factor alone is adequate for the world to decide on certain vegetable oils that will be produced extensively to meet the expanding requirements for greener and cleaner energy.

The added advantage of using Palm Oil is that it is less susceptible to the vagaries of the weather compared to other vegetable oils. Being a perennial tree crop, it produces oil the whole year round and is not harmful to the environment like annual crops. This would ensure a constant supply of raw material for the Biodiesel industry.

In international markets where petroleum diesel is not subsidised, Palm Biodiesel will be a very viable investment. Common raw materials for the production of Biodiesel are rapeseed oil and soybean oil. In the current global market, these oils are traded at a premium of US$150/tonne over Palm Oil.

Impact of Crude Oil Price on Biodiesel Viability



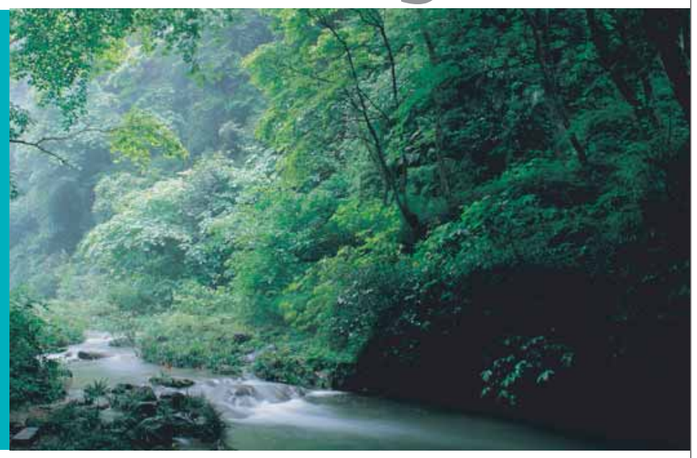
Palm Biodiesel

The Environment Factor : Projecting A **Green** Image

As a perennial crop, Palm Oil maintains green canopy throughout its 30 years of economic life compared to annual crops like Soya Bean which is only able to maintain its green affect for a few months in a year.

Studies have also confirmed that Palm Oil-based products are much easily degraded than those based on petrochemical-derived feedstock.

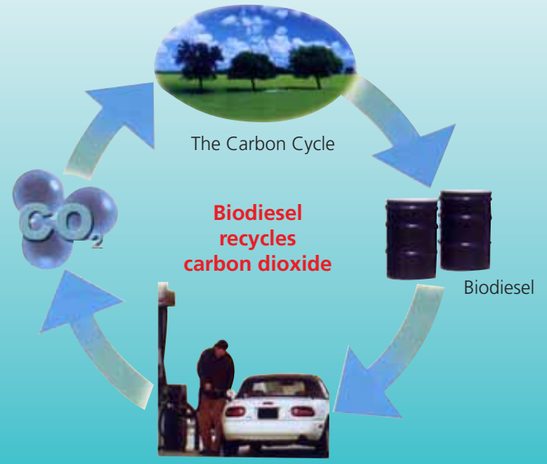
Thus, it is clear that Palm Oil promotes optimal impact on the environment and is able to meet a sizeable proportion of the world's needs for energy and Oils and Fats.



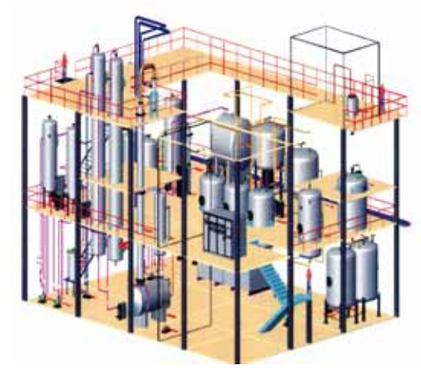
The Carbon Cycle

All Biofuels are derived from the conversion of sunlight to energy that takes place in the green leaves of plants. Plants take up carbon dioxide (CO_2) from the atmosphere; burning plant (or animal) products in an engine releases the CO_2 uptake back into the atmosphere.

The CO_2 released into the atmosphere when Biodiesel is being burned is recycled by growing plants, which are later processed into fuels. The recycled CO_2 causes the atmospheric CO_2 levels to remain constant. Due to its closed carbon cycle, Biodiesel do not increase the Greenhouse Effect compared to fossil fuels, which release large amounts of new (or rather very old) CO_2 which has been locked away from the atmosphere. In fact, Biodiesel can actually reduce CO_2 level in the atmosphere: growing soybeans consumes nearly four times as much CO_2 as the amount of CO_2 produced in the exhaust from soybean oil Biodiesel.



Source: Biodiesel Association of Australia



3 Dimensional Plant Layout.

- **Capacities of plant available**
  From 8000 to 60 000 metric tons per year
  Further sizes subject to final design
- **Delivery**
  Delivery of process plant in 8 to 10 months

MPOB has conducted intensive research and development on Palm Biodiesel technology over the last 20 years. Combining expertise with its established partner, LIPOCHEM, MPOB aims to be successful in introducing this improved technology into the local and international market. With low capital and operating cost, the LIPOCHEM-MPOB plant is also designed for energy efficiency and safety. It is also the only plant design that is optimised for Palm Oil and Palm products as feedstock.

The produce from the plant can further proceed into winter-grade Biodiesel and feedstock for surfactants and detergents. Due to mild processing conditions (low temperature, low pressure and minimum usage of chemicals), the phytonutrients of Palm Oil, carotenes and Vitamin E, remain intact in the produce from the plant. These phytonutrients can be extracted as high value health supplements.

MPOB has successfully developed processes to recover these valuable products. It is estimated that if the vital nutrients carotenes and vitamin E are recovered, the income generated from the sales of the carotenes and vitamin E is able to cover the investment. This will make Palm Biodiesel a byproduct. The economic analysis will be totally different and this will render this project even more viable.

Why choose LIPOCHEM-MPOB Palm **Biodiesel Plant**

Potential Market

The EU is at the forefront of Biodiesel consumption. In the EU, the problem of the Biodiesel market is the inability of production capacity to meet EU targets. This is mainly because of the inadequate supply of cultivable land and feedstock oil. The EU is now in the midst of a transition from experimentation with Biofuels to implementing Biofuels into its policies. The main countries using Biodiesel are Germany, Italy and France.

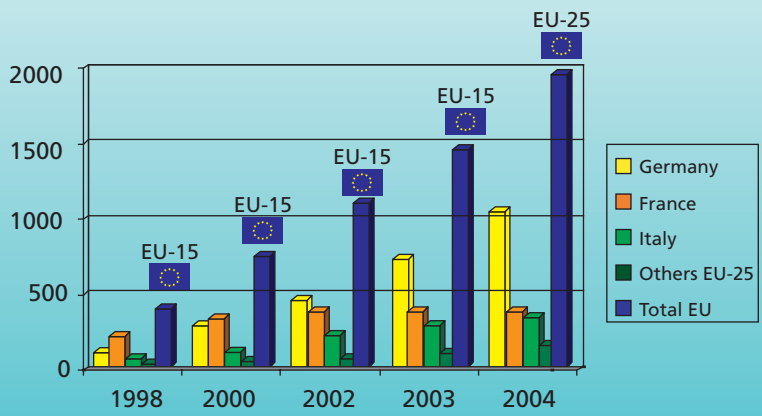
Germany started producing Biodiesel on a commercial scale in 1991 and is the world's leading user of Biodiesel produced from rapeseed oil. In 2003, the production of Biodiesel increased to 715 000 tonnes from 450 000 in 2002. However, with the consumption of Biodiesel increasing due to rising oil prices, it will be challenging for Germany to meet the demands of supplying Biodiesel made only from locally grown rapeseed. One way for Germany to combat this inadequacy is to import Palm Biodiesel. Since Malaysia is well ahead in producing, exporting and developing Palm Biodiesel, we will be able to capitalise on the expanding demand.

EU-25 Demand and Market Potential
Projections for Gasoline and Diesel Consumption in Transport 2005-2010
Amount of Biofuel Needed to Meet and Indicative Transport Biofuel Targets
Million Tonnes Oil Equivalent (toe)

	2005	**2006**	**2007**	**2008**	**2009**	**2010**
Fossil Gasoline	133.0	134.2	135.4	136.6	137.8	139.1
Fossil Diesel	159.9	163.3	166.8	170.4	174.1	177.8
Total	292.9	297.5	302.2	307.0	311.9	316.9
Biofuel %	**2.00%**	**2.75%**	**3.50%**	**4.25%**	**5.00%**	**5.75%**
Bioethanol	2.7	3.7	4.7	5.8	6.9	8.0
Biodiesel	3.2	4.5	5.8	7.2	8.7	10.2
Total	5.9	8.2	10.6	13.0	15.6	18.2

Note: One tonne of oil equivalent of Biodiesel is equivalent approximately 1.1 metric tonnes
Source: Biofuel Potential in the EU, IPTS, JRC, European Commission, Jan. 2004

EU Biodiesel Production in Member States and in the EU ('000 t)



Source: European Biodiesel Board; National Biodiesel Board USA

The potential market is not only in EU. Government support for Biodiesel production and utilisation in the form of subsidies and tax incentives is a global trend.

In the US, a blend of 20% Biodiesel with 80% petroleum diesel is widely used. Many US states have passed legislation favouring Biodiesel and a new tax incentive signed in 2004 for Biodiesel productions demonstrates an increasing support for edible oil prices.

In Australia, a Biodiesel package released in 2003 provides producers and importers of domestic Biodiesel with subsidies and a net effective excise rate of zero for Biodiesel.

Japan, Korea, China and Thailand have also expressed strong interests in Biodiesel and are among many countries that are now seriously evaluating their own indigenous vegetable oils as renewable energy sources.

All of these developments underscore environmental benefits in terms of lesser green house gas emission and economical benefits in terms of reduced dependence on the fossil fuel imports and positive impact on agriculture.

FAQs FREQUENTLY ASKED QUESTIONS

1) Can Palm Biodiesel be used directly in diesel engines?

Neat Palm Biodiesel (straight non-mixed biodiesel) can be used as fuel in diesel engine without any engine modification. It can also be blended in any proportions with petroleum diesel. Palm Biodiesel is simple to use.
To run on neat Palm Oil though, it is advisable to use modified diesel engines with proper heating device or new type of diesel engines, e.g. Elsbett engine.

2) What is the viability of the Palm Biodiesel project?

Technically it has been proven viable. It is very feasible for a global market where petroleum diesel is very expensive, like in the EU. This will make the price(s) of Palm Biodiesel very competitive.

3) What other benefits can be derived from Palm Biodiesel project?

It creates new business and job opportunities for Malaysia. It also provides opportunity to manufacture phytonutrients such as carotenes (pro-vitamin A) and vitamin E.

4) How do you ensure the quality of Palm Biodiesel in Malaysia?

The quality of Palm Biodiesel will be that of European Standard for Biodiesel (EN14214)

5) Is it cheaper to use Palm Biodiesel?

One of the stumbling blocks for the future growth of Palm Biodiesel is understandable the high cost of vegetable oil and cheap petroleum price in our country. This may not be true anymore due to the current escalating petroleum prices. Furthermore, with the anticipated depletion of petroleum reserves, Palm Oil fuel will become more economically attractive. Now is the best time to introduce Palm Biodiesel in to Malaysia especially with the added benefit of a clean and healthy environment.

6) How much work has been done in Malaysia on Biodiesel?

Malaysian Palm Oil Board (MPOB) has conducted extensive research and development in using Palm Biodiesel as diesel substitute. They have been used in pure form or blended with petroleum diesel or fuel oil in diesel engines and industrial burners. The results are very promising and we are hoping to follow in the footsteps of our foreign counterparts who have used Palm Biodiesel as fuel in commercial trains and received positive feedback.

Take a step into the future

Research and development is important because experience shows that such efforts have assisted us in expanding the usage scope of Palm Oil. In the field of Biodiesel, MPOB has initiated research well ahead of other developed countries.

LIPOCHEM, in collaboration with MPOB, has contributed its technical expertise by designing and scaling up the commercial plant. This partnership has resulted in the development of the most cost effective and efficient plant as well as discovering the latest breakthrough in the Palm Biodiesel technology. To commercialise the R&D findings, the experience and engineering expertise of a forward-looking company like LIPOCHEM is vital. The LIPOCHEM-MPOB collaboration has provided the technological and economical inputs to allow the Malaysian Palm Oil Industry to take the lead in the new global Biodiesel industry.

It is recognised that R&D and industrial engineering expertise are important for the future development of this sector and all findings and innovations made are in-line with the needs of the industry. Through sustained and systematic research and development efforts, Malaysia will prove to be a reliable supplier of Palm Biodiesel and innovative technologies for the global Biodiesel industry.