Editorial

O
ne of the frequently over-
looked maintenance aspect of a
palm oil mill without doubt, is
monitoring the condition of the mea-
suring devices installed in a mill. With
most meters displaying inaccurate
readings or no readings at all in most
mills, it is surprising how engineers
can process the crop in a scientific
way. As the weighing bridge is closely
tied to money transactions and also
to the regulatory department, its accuracy
is somehow maintained satisfactorily
by mills. But even this could run out of ac-
curacy when the mechanical weighing
bridge is used. Apart from this, most
other measuring devices are installed
with very little regular maintenance.

Some of these meters and instru-
ments have direct impact on processing
efficiency. One of them is the thermo-
meter. The mill oil extraction efficiency
is directly related to the temperature
of the digester, crude oil tank and the
clarification tank. The oil loss in sludge
can be as much as even 1% (as a % to
FFB) if the temperature is 85°C instead
of 95°C. This is the reason why MPOB is
insisting on the availability of sufficient
heating steam for the mill when mills
request for expansion. If steam supply
is inadequate in a mill, the chances are
that a good amount of oil will be lost in
sludge. By getting that extra oil, mills
can extract more oil and increase their
profits.

Heating is a very important elemen-
tary step for good oil extraction and
most mills are aware of this. Some mills
claim that since their boilers operate at
higher pressures than the conventional
boilers they need not have the same
mass of steam as mills operating boilers at lower pressure for their processing needs. This is clearly a misconception and lest the mill engineers have forgotten their basic thermodynamics, an effort is being made in this issue to highlight some of the salient points for refreshing their memory.

Another area where the measurement plays an important role is in kernel recovery. Variables like the de-pericarp column (also called wind box) throat area and the LTDS cyclone discharge chute flap at ID fan outlet set at commissioning time remains unchanged for life! In some mills, no attention is being given to at least measure the separating velocities at critical points. All these values are important for proper processing, aimed for high extraction ratios. This requires the use of a velocity measuring device and even though it costs only about RM 600, it is unlikely many mills have this. The separating velocities will change according to the ID fan air flow volume rate due to wear of the fan blades. If the throat velocity is not adjusted to accommodate the flow rate, the lifting velocity and separation efficiency will change. Some tips on these are given in this bulletin.

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**CALL FOR ARTICLES**

The millers are requested to send in articles of relevance to the palm oil industry in Malaysia for publication in *Palm Oil Engineering Bulletin*. By sharing your expertise you will be helping the industry and the nation as a whole. The topics of interest are:

1. Plant modifications done in your mill that resulted in improvements in milling operation or maintenance.
2. Innovations done in your mill that produced improvements in the operation of the mill and that you are willing to share them with others.
3. Any special work done in your mill that directly resulted in improvements in OER and product quality.

Please submit your article to us and we shall be pleased to publish them in Palm Oil Engineering Bulletin. Feel proud to have your articles published in this Bulletin that is circulated throughout the industry and MPOB offices worldwide.
Seminar on Palm Oil Product Safety during Transportation

The Seminar on Palm Oil Product Safety during Transportation was officiated by Datuk Peter Chin Fah Kui, the Minister of Plantation Industries and Commodities, on 13 January 2009 at MPOB Head Office, Bangi.

During the function, MPOB and the Royal Malaysian Police (PDRM) exchanged a memorandum of understanding (MoU) to jointly tackle criminal activities in the industry, like theft and adulteration of palm products during shipment. Dato’ Dr Mohd Basri Wahid, the Director-General, represented MPOB, while Tan Sri Ismail Omar, the Deputy Inspector-General of Police, represented PDRM.

Dato’ Sabri Ahmad, the Chairman of MPOB and Mr M Nagarajan, the Under Secretary of the Vegetable Oils, Fats and Sago Industry Division of the Ministry of Plantation Industries and Commodities, also attended the function.

MoU between MPOB and Be Bioenzyme Enterprise

Datuk Peter Chin Fah Kui, the Minister of Plantation Industries and Commodities, witnessed the signing of a memorandum of understanding (MoU) between MPOB and Be Bioenzyme Enterprise for a collaborative venture to conduct research on biological control of palm diseases using bio-herb-based products.

The product will be used to control Ganoderma, a fungus which causes basal
Recent Events

Recent Events

oil palm stem rot disease. Based on the experience and monitoring work done by the company, this bio-herb-based product can protect oil palm trunks from *Ganoderma* infection. The company has also formulated other products, namely, *Be Herbal Detox*, *Be Herbal Enzymes* and *Be Herbal Special Ingredient* in addition to the *Be Herbal Organic Fertilizer*.

Dato’ Dr Mohd Basri Wahid, the Director-General represented MPOB, while Mr Goh Bee San, represented Be Bio-enzyme Enterprise.

5th Farm Mechanization Operator’s Course

Dato’ Dr Mohd Basri Wahid, the Director-General of MPOB presented certificates to the 28 successful participants of the 5th Farm Mechanization Operator’s Course, at MPOB Head Office on 12 February 2009. The three best performers among them also received their rewards during the function.

Dato’ Dr Choo Yuen May, Deputy Director-General (R&D); Dr Ahmad Kushairi Din, Director of Biological Research; MPOB officials, lecturers and parents of participants also attended the function.
Recent Events

First Delivery of Bio-diesel Blend (B5) from KVDT

The Klang Valley Distribution Terminal (KVDT) successfully delivered its first batch of B5 or a blend of 5% methyl ester from palm oil and 95% petroleum diesel to distribution depots owned by the Malaysian Armed Forces (ATM) and Kuala Lumpur City Hall (DBKL) on 3 February 2009 at KVDT, Jalan Dengkil-Puchong.

Official Opening of MPOB Office at Tawau

Dato’ Dr Mohd Basri Wahid, the Director-General of MPOB, officiated the opening of MPOB branch office in Tawau on 10 February 2009. The branch office started operations since August 2008. More than 50 invitees from several government departments and agencies, associations and industry in and around Tawau, Semporna and Kunak, Sabah attended the event.

The opening of the new office in Tawau signifies MPOB’s commitment to effectively serve the industry including providing the licensing, enforcement, quality control and advisory services in terms of planting of oil palm, and research activities such as livestock and crop integration with oil palm.

Dato’ Dr Choo Yuen May, Deputy Director-General (R&D); Dr Salmiah Ahmad, Deputy Director-General (Services) and Haji Adzmi Hassan, Director of Licensing and Enforcement, also attended the event.
## Forthcoming Events

### 2009 MPOB Training Programme Schedule

<table>
<thead>
<tr>
<th>CODE NO.</th>
<th>COURSES</th>
<th>TITLE</th>
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<th>VENUE</th>
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<tr>
<td>A</td>
<td>OIL PALM</td>
<td><strong>Kursus Kemahiran Menggred Buah Sawit</strong></td>
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</tr>
<tr>
<td>A1.1</td>
<td></td>
<td>Bil. 1: Wilayah Utara</td>
<td>24-26 Mac</td>
<td>Hotel Legend Inn, Taiping, Perak</td>
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<tr>
<td></td>
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<td>Bil. 2: Wilayah Sabah</td>
<td>28-30 April</td>
<td>Hotel Emas, Tawau, Sabah</td>
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<tr>
<td></td>
<td></td>
<td>Bil. 3: Wilayah Sarawak</td>
<td>26-28 Mei</td>
<td>Hotel Four Point, Kuching, Sarawak</td>
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<td></td>
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<td>Bil. 4: Wilayah Tengah</td>
<td>23-25 Jun</td>
<td>Negeri Sembilan</td>
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<td><strong>Peperiksaan Kemahiran Menggred Buah Sawit</strong></td>
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<td></td>
<td></td>
<td>Peperiksaan Bil. 12: Sabah</td>
<td>28 Julai</td>
<td>*</td>
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<tr>
<td></td>
<td></td>
<td>Peperiksaan Bil. 13: Semenanjung</td>
<td>25 Ogos</td>
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<tr>
<td>A1.2</td>
<td></td>
<td><strong>11th Intensive Diploma in Oil Palm Management &amp; Technology (IDOPMT)</strong></td>
<td></td>
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<td></td>
<td></td>
<td>Semester I</td>
<td>13 April-8 May</td>
<td>MPOB HQ</td>
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<td></td>
<td>Estate Attachment</td>
<td>11-22 May</td>
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<td></td>
<td>Semester II</td>
<td>25 May-18 June</td>
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<td></td>
<td></td>
<td>Estate Attachment</td>
<td>22 June-3 July</td>
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<td>Semester III</td>
<td>6-30 July</td>
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<td>A1.3</td>
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<td><strong>Kursus Operator Mekanisasi Ladang</strong></td>
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<td>Feb-Julai</td>
<td>PLASMA, MPOB UKM</td>
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<td>Ogos-Jan. 2010</td>
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### Forthcoming Events

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<tr>
<td><strong>A1.4</strong></td>
<td>Kursus Pengurusan dan Penyelenggaraan Tapak Semaian Sawit</td>
<td>10-11 Feb</td>
<td>Hotel Dynasty, Miri, Sarawak</td>
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<td>Bil. 1: Wilayah Sarawak</td>
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<td>Bil. 2: Wilayah Sabah</td>
<td>14-15 April</td>
<td>Hotel Sandakan, Sandakan, Sabah</td>
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<td>Bil. 3: Wilayah Selatan</td>
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<td>Kluang, Johor</td>
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<td>Bil. 4: Wilayah Timur</td>
<td>11-12 Ogos</td>
<td>Kuantan, Pahang</td>
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<td>Bil. 5: Wilayah Utara</td>
<td>6-7 Okt</td>
<td>Perak</td>
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<th>PALM OIL</th>
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<tr>
<td><strong>A2.1</strong></td>
<td>Diploma in Palm Oil Milling Technology and Management (DIPOM)</td>
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<tr>
<td></td>
<td>Semester I</td>
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<tr>
<td></td>
<td>Semester II</td>
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<td></td>
<td>Semester III</td>
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<tr>
<td></td>
<td>Exam. Semester III</td>
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<tr>
<td><strong>A2.2</strong></td>
<td>The 23rd MPOB Oil Palm Products Surveying Course</td>
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<tr>
<td></td>
<td>The 22nd MPOB Oil Palm Products Surveying Examination</td>
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<tr>
<td><strong>A2.3</strong></td>
<td>Kursus Penyelia Kilang Minyak Sawit Peperiksaan</td>
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<td></td>
<td>29 Julai</td>
</tr>
<tr>
<td><strong>A2.4</strong></td>
<td>Kursus Pengendali Makmal Kilang Minyak Sawit Peperiksaan</td>
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<tr>
<td></td>
<td>31 Julai</td>
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<tr>
<td><strong>A2.5</strong></td>
<td>Colour Cosmetic Course</td>
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### 2009 MPOB CONFERENCES/SEMINARS

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<th>TITLE</th>
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<th>VENUE</th>
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<tr>
<td><strong>B</strong></td>
<td>CONFERENCES/SEMINARS</td>
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<tr>
<td>1.</td>
<td>Seminar Keselamatan Pengalihan Keluaran Kelapa Sawit</td>
<td>13 Jan.</td>
<td>MPOB HQ</td>
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<td>2.</td>
<td>Programme Advisory Committee (PAC) Seminars</td>
<td>9 April</td>
<td>MPOB HQ</td>
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<td>3.</td>
<td>International Conference on Palm Oil and the Environment</td>
<td>14-15 August</td>
<td>MAEP, Serdang, Selangor</td>
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<tr>
<td>CODE NO.</td>
<td>TITLE</td>
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<td>VENUE</td>
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<td>B 4.</td>
<td>MPOB Transfer of Technology (TOT) Seminar 2009</td>
<td>18 June</td>
<td>MPOB HQ</td>
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<td>B 5.</td>
<td>SFRR/MPOB Conference</td>
<td>9-12 July</td>
<td>MERITUS Pelangi Beach Resort &amp; Spa, Langkawi</td>
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<td>B 6.</td>
<td>TOT IKS Seminar</td>
<td>July</td>
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<td>B 7.</td>
<td>GSAS Seminar</td>
<td>11 June</td>
<td>MPOB HQ</td>
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<td>B 8.</td>
<td>PIPOC 2009</td>
<td>9-12 Nov.</td>
<td>KLCC, Kuala Lumpur</td>
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Notes:  
* To be confirmed.  
+ By invitation.  
** Course approved under PROLUS scheme of Pembangunan Sumber Manusia Berhad.

For enquiry or further information, please contact:

HRD & Conference Management Unit  
Tel. No. : 03-87694400 ext. 4865, 4860, 4867  
Fax No. : 03-89257549  
E-mail : rubaah@mpob.gov.my  
MPOB’s website : http://www.mpob.gov.my
Maintenance and Troubleshooting of Electric Motors

S Jagathisen*

The key to minimizing motor problems is scheduled routine inspection and service. The frequency of routine service varies widely between applications.

It is usually sufficient to include motors in the maintenance schedule for the driven machine or the general plant equipment. A motor may require additional or more frequent attention if a breakdown would cause health or safety problems, severe loss of production, damage to expensive equipment or other serious losses.

Written records indicating date, items inspected, service performed and motor condition are important to an effective routine maintenance programme. From such records, specific problems in each application can be identified and solved routinely to avoid breakdowns and production losses.

The routine inspection and servicing can generally be done without disconnecting or disassembling the motor. It involves the following factors.

Dirt and Corrosion

- Wipe, brush, vacuum or blow accumulated dirt from the frame and air passages of the motor. Dirty motors run hot when thick dirt insulates the frame and clogged passages reduce cooling air flow. Heat reduces insulation life and eventually causes motor failure.
- Using the palm, feel for air being discharged from the cooling air ports. If the flow is weak or unsteady, internal air passages are probably clogged. Remove the motor from service and clean.
- Check for signs of corrosion. Serious corrosion may indicate internal deterioration and/or a need for external repainting. Schedule the removal of the motor from service for complete inspection and possible rebuilding.
- In wet or corrosive environments, open the conduit box and check for deteriorating insulation or corroded terminals. Repair as needed.

Lubrication

Lubricate the bearings only when scheduled or if they are noisy or running hot. Do not over lubricate. Excessive grease and oil creates dirt and can damage bearings. See Bearing Lubrication for more details.

Heat, Noise and Vibration

Feel the motor frame and bearings for excessive heat or vibration. Listen for ab-
normal noise. All of them indicate a possible system failure. Promptly identify and eliminate the source of the heat, noise or vibration. See Heat, Noise and Vibration for details.

**Winding Insulation**

When records indicate a tendency towards periodic winding failures in the application, check the condition of the insulation with an insulation resistance test. See Testing Windings for details. Such testing is especially important for motors operating in wet or corrosive atmospheres or in high ambient temperatures.

**Brushes and Commutators (DC motors)**

- Observe the brushes while the motor is running (*Figure 1*). The brushes must ride on the commutator smoothly with little or no sparking and no brush noise (chatter).

- Stop the motor. Be certain that:
  
i. The brushes move freely in the holder and the spring tension on each brush is about equal.

  ii. Every brush has a polished surface over the entire working face indicating good seating.

  iii. The commutator is clean, smooth and has a polished brown surface where the brushes ride. Note: Always put each brush back into its original holder. Interchanging brushes decreases commutation ability.

  iv. There is no grooving of the commutator (small grooves around the circumference of the commutator). If there is grooving, remove the motor from service immediately as this is a symptomatic indication of a very serious problem.

- Replace the brushes if there is any chance they will not last until the next inspection date.

- If dirt accumulates, remove it from grooves between the commutator bars and from the brush holders and posts.

- Brush sparking, chatter, excessive wear or chipping, and a dirty or rough commutator indicate motor problems requiring prompt service. See Brush and Commutator Care for details.

**Brushes and Collector Rings (synchronous motors)**

- Black spots on the collector rings must be removed by rubbing lightly with fine sandpaper. If not removed, these spots can cause pitting that requires regrinding of rings (*Figure 2*).

- An imprint of the brush, signs of arcing or uneven wear indicate the need to remove the motor from service and repair or replace the rings.

- Check the collector ring brushes as described under Brushes and Commutators. They do not, however, wear as rapidly as commutator brushes.

*Figure 1. Typical DC motor brushes and commutator.*
Modern motor designs usually provide a generous supply of lubricant in tight bearing housings. Lubrication on a scheduled basis, in conformance with the manufacturer’s recommendations, provides optimum bearing life.

Thoroughly clean the lubrication equipment and fittings before lubricating. Dirt introduced into the bearings during lubrication probably causes more bearing failures than the lack of lubrication.

Too much grease can overpack bearings and cause them to run hot, shortening their life.

Excessive lubricant can find its way inside the motor where it collects dirt and causes insulation deterioration.

Many small motors are built with permanently lubricated bearings. They cannot and should not be lubricated.

**Oiling Sleeve Bearings**

As a general rule, fractional horsepower motors with a wick lubrication system should be oiled every 2000 hr of operation or at least annually. Dirty, wet or corrosive locations or heavy loading may require oiling at three-month intervals or more often. Roughly 30 drops of oil for a 76 mm diameter frame to 100 drops for a 230 mm diameter frame is sufficient. Use a 150 SUS viscosity turbine oil or SAE 10 automotive oil.

Some larger motors are equipped with oil reservoirs and usually a sight gage to check proper level (Figure 3).

As long as the oil is clean and light in colour, the only requirement is to fill the cavity to the proper level with the oil recommended by the manufacturer. Do not overfill the cavity. If the oil is discoloured, dirty or contains water, remove it through the drain outlet. Flush the bearing with fresh oil until it comes out clean. Coat the plug threads with a sealing compound, replace the plug and fill the cavity to the proper level.

When motors are disassembled, wash the housing with a solvent. Discard used felt packing. Replace badly-worn bearings. Coat the shaft and bearing surfaces with oil and reassemble.

**Greasing Ball and Roller Bearings**

Practically, all Reliance ball bearing motors in current production are equipped with the exclusive PLS/positive lubrication system (Figure 4). PLS is a patented open-bearing system that provides long, reliable bearing and motor life regardless of the mounting position. Its special internal passages uniformly distribute new grease
pumped into the housing during regreasing through the open bearings and forces old grease out through the drain hole. The close running tolerance between shaft and inner bearing cap minimizes entry of contaminants into the housing and grease migration into the motor. The unique V-groove outer slinger seals the opening between the shaft and end bracket, while the motor is running or is at rest yet allows relief of grease along the shaft if the drain hole is plugged.

The frequency of routine greasing increases with motor size and severity of the application as indicated in Table 1. Actual schedules must be selected by the user for the specific conditions.

During scheduled greasing, remove both the inlet and drain plugs. Pump grease into the housing using a standard grease gun and light pressure until clean grease comes out of the drain hole.

If the bearings are hot or noisy even after correction of bearing overloads, remove the motor from service. Wash the housing and bearings with a good solvent. Replace bearings that show signs of damage or wear. Repack the bearings, assemble the motor and fill the grease cavity.

Whenever motors are disassembled for service, check the bearing housing. Wipe out any old grease. If there are any signs of grease contamination or breakdown, clean and repack the bearing system as described in the preceding paragraph.

**HEAT, NOISE AND VIBRATION**

**Heat**

Excessive heat is both a cause of motor failure and a sign of other motor problems.

The primary damage caused by excess heat is to increase the ageing rate of the insulation. Heat beyond the insulation’s rating shortens winding life. After overheating, a motor may run satisfactorily but its useful life will be shortened. For maximum motor life, the cause of overheating should be identified and eliminated.
## Feature Article

### TABLE 1. MOTOR OPERATING CONDITIONS

<table>
<thead>
<tr>
<th>Motor horsepower</th>
<th>Light duty (year)</th>
<th>Standard duty</th>
<th>Heavy duty</th>
<th>Severe duty (month)</th>
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</thead>
<tbody>
<tr>
<td>Up to 7-0.5</td>
<td>10</td>
<td>7 years</td>
<td>4 years</td>
<td>9</td>
</tr>
<tr>
<td>10 to 40</td>
<td>7</td>
<td>4 years</td>
<td>1-0.5 years</td>
<td>4</td>
</tr>
<tr>
<td>50 to 150</td>
<td>4</td>
<td>1-0.5 years</td>
<td>9 months</td>
<td>3</td>
</tr>
<tr>
<td>Over 150</td>
<td>1</td>
<td>6 months</td>
<td>3 months</td>
<td>2</td>
</tr>
</tbody>
</table>

Overheating results from a variety of different motor problems. They can be grouped as follows:

- wrong motor. It may be too small or have the wrong starting torque characteristics for the load. This may be the result of poor initial selection or changes in the load requirements;

- poor cooling. Accumulated dirt or poor motor location may prevent the free flow of cooling air around the motor. In other cases, the motor may draw heated air from another source. Internal dirt or damage can prevent proper air flow through all sections of the motor. Dirt on the frame may prevent transfer of internal heat to the cooler ambient air;

- overloaded driven machine. Excess loads or jams in the driven machine force the motor to supply higher torque, draw more current and overheat.

- light duty. Motors operate infrequently (1 hr day\(^{-1}\) or less) as in portable floor sanders, valves, door openers;

- standard duty. Motors operate in normal applications (one or two work shifts). Examples include air conditioning units, conveyors, refrigeration apparatus, laundry machinery, woodworking and textile machines, water pumps, machine tools and garage compressors;

- heavy duty. Motors subjected to above normal operation and vibration (running 24 hr day\(^{-1}\), 365 days yr\(^{-1}\)). Such operations as in steel mill service, coal and mining machinery, motor-generator sets, fans, pumps;

- severe duty. Extremely harsh, dirty motor applications. Severe vibration and high ambient conditions often exist;

- excessive friction. Mis-alignment, poor bearings and other problems in the driven machine, power transmission system or motor increase the torque required to drive the loads, raising motor operating temperature; and

- electrical overloads. An electrical failure of a winding or connection in the motor can cause other windings or the entire motor to overheat.

### Noise and Vibration

Noise indicates motor problems but ordinarily does not cause damage. Noise, however, is usually accompanied by vibration.

Vibration can cause damage in several ways. It tends to shake windings loose and mechanically damages insulation by cracking, flaking or abrading the material. Embrittlement of lead wires from excessive movement and brush sparking at commutators or current collector rings also results from vibration. Finally, vibration can speed bearing failure by causing balls to brinnell, sleeve bearings to be pounded out of shape or the housings to loosen in the shells.
Whenever noise or vibration are found in an operating motor, the source should be quickly isolated and corrected. What seems to be an obvious source of the noise or vibration may be a symptom of a hidden problem. Therefore, a thorough investigation is often required.

Noise and vibrations can be caused by a mis-aligned motor shaft or can be transmitted to the motor from the driven machine or power transmission system. They can also be the result of either electrical or mechanical unbalance in the motor.

After checking the motor shaft alignment, disconnect the motor from the driven load. If the motor then operates smoothly, look for the source of noise or vibration in the driven equipment.

If the disconnected motor still vibrates, remove power from the motor. If the vibration stops, look for an electrical unbalance. If it continues as the motor coasts without power, look for a mechanical unbalance.

Electrical unbalance occurs when the magnetic attraction between stator and rotor is uneven around the periphery of the motor. This causes the shaft to deflect as it rotates creating a mechanical unbalance. Electrical unbalance usually indicates an electrical failure such as an open stator or rotor winding, an open bar or ring in squirrel cage motors or shorted field coils in synchronous motors. An uneven air gap, usually from badly worn sleeve bearings, also produces electrical unbalance.

The chief causes of mechanical unbalance include a distorted mounting, bent shaft, poorly balanced rotor, loose parts on the rotor or bad bearings. Noise can also come from the fan hitting the frame, shroud or foreign objects inside the shroud. If the bearings are bad, as indicated by excessive bearing noise, determine why the bearings failed.

Brush chatter is a motor noise that can be caused by vibration or other problems unrelated to vibration.

WINDINGS

Care of Windings and Insulation

Except for expensive, high horsepower motors, routine inspections generally do not involve opening the motor to inspect the windings. Therefore, long motor life requires selection of the proper enclosure to protect the windings from excessive dirt, abrasives, moisture, oil and chemicals.

When the need is indicated by severe operating conditions or a history of winding failures, routine testing can identify deteriorating insulation. Such motors can be removed from service and repaired before unexpected failures disrupt production (see Testing Windings).

Whenever a motor is opened for repair, service the windings as follows:

- accumulated dirt prevents proper cooling and may absorb moisture and other contaminants that damage the insulation. Remove the dirt from the windings and internal air passages using a vacuum cleaner. Do not use high pressure air because this can damage windings by driving the dirt into the insulation;
- abrasive dust drawn through the motor can abrade coil noses, removing insulation. If such abrasion is found, the winding should be revarnished or replaced;
- moisture reduces the dielectric strength of insulation which results in shorts circuits. If the inside of the motor is damp, dry the motor per information in Cleaning and Drying Windings;
• wipe any oil and grease from inside the motor. Use care with solvents that can attack the insulation;

• if the insulation appears brittle, overheated or cracked, the motor should be revarnished or, with severe conditions, rewound;

• loose coils and leads can move with changing magnetic fields or vibration, causing the insulation to wear, crack or fray. Revarnishing and retying leads may correct minor problems. If the loose coil situation is severe, the motor must be rewound;

• check the lead-to-coil connections for signs of overheating or corrosion. These connections are often exposed on large motors but taped on small motors. Repair as needed;

• check wound rotor windings as described for stator windings. Because rotor windings must withstand centrifugal forces, tightness is even more important. In addition, check for loose pole pieces or other loose parts that create unbalance problems; and

• the cast rotor rods and end rings of squirrel cage motors rarely need attention. However, open or broken rods create electrical unbalance that increases with the number of rods broken. An open end ring causes severe vibration and noise.

Testing Windings

Routine field testing of windings can identify deteriorating insulation permitting scheduled repair or replacement of the motor before its failure disrupts operations. Such testing is good practice especially for applications with severe operating conditions or a history of winding failures and for expensive, high horsepower motors and locations where failures can cause health and safety problems or high economic loss.

The easiest field test that detects and prevents most failures is the ground-insulation test. It applies a DC voltage, usually 500 or 1000 volts, to the motor and measures the resistance of the insulation.

NEMA standards require a minimum resistance to ground at 40°C ambient of 1 megohm per kilovolt of rating plus 1 megohm. Medium size motors in good condition will generally have megohmmeter readings in excess of 50 megohms. Low readings may indicate a seriously reduced insulation condition caused by contamination from moisture, oil or conductive dirt or deterioration from age or excessive heat.

One megger reading for a motor means little. A curve recording resistance, with the motor cold and hot, and date indicates the rate of deterioration. This curve provides the information needed to decide if the motor can be safely left in service until the next scheduled inspection time.

The megger test indicates ground insulation condition. It does not, however, measure turn-to-turn insulation condition and may not pick up localized weaknesses. Moreover, operating voltage peaks may stress the insulation more severely than megger voltage. For example, the DC output of a 500-volt megger is below the normal 625-volt peak each half cycle of an AC motor operating on a 440-volt system. Experience and conditions may indicate the need for additional routine testing.

A test used to prove the existence of a safety margin above operating voltage is the AC high potential ground test. It applies a high AC voltage (typically, 65% of a voltage times twice the operating voltage plus 1000 volts) between windings and frame.
Although this test does detect poor insulation condition, the high voltage can produce arc to the ground, burning the insulation and the frame, and can also actually damage the winding during the test. It should never be applied to a motor with a low megger reading.

DC high potential tests are becoming more popular than AC tests because the test equipment is smaller, and the low test current safer to the people and also the equipment itself.

Cleaning and Drying Windings

Motors which have been flooded or which have low megger readings because of contamination by moisture, oil or conductive dust should be thoroughly cleaned and dried. The methods depend upon available equipment.

A hot water hose and detergents are commonly used to remove dirt, oil, dust or salt concentrations from rotors, stators and connection boxes. After cleaning, the windings must be dried, commonly in a forced-draft oven. Time to obtain acceptable megger readings varies from a couple of hours to a few days.

**BRUSH AND COMMUTATOR CARE**

Some maintenance personnel with many relatively trouble-free AC squirrel cage motors forget that brushes and commutators require frequent routine inspection and service. This could lead to unnecessary failures between scheduled maintenance.

Many factors are involved in brush and commutator problems. All generally involve brush sparking usually accompanied by chatter and often excessive wear or chipping. Sparking may cause poor commutator conditions or vice versa.

The degree of sparking should be determined by careful visual inspection. The illustrations shown in Figure 5 are a useful guide. It is very important to gauge the degree number as accurately as possible. The solution to the problem may well depend upon the accuracy of this assessment since any motor, load, environmental on application conditions can trigger sparking.

It is also imperative that a remedy be determined as quickly as possible. Sparking generally feeds upon itself and worsens with time until serious damage results.

Some causes are obvious and some are not. Some are constant and others intermittent. Therefore, eliminating brush sparking, especially when it is a chronic or recurring problem, requires a thorough review of the motor and operating conditions. Always recheck for sparking after correcting each problem to ensure that there are no more problems. Also remember that, after grinding the commutator and properly reseating the brushes, sparking will occur until the polished, brown surface reforms on the commutator.
First consider external conditions that affect commutation. Frequent motor overloads, vibration and high humidity cause sparking. Extremely low humidity allows brushes to wear through the polished brown commutator surface film. Oil, paint, acid and other chemical vapours in the atmosphere contaminate brushes and the commutator surface.

Look for obvious brush and brush holder deficiencies:

- be sure brushes are properly seated, move freely in the holders and are not too short;
- the brush spring pressure must be equal on all brushes;
- be sure spring pressure is not too light or too high. Large motors with adjustable springs should be set at about 0.2 to 0.3 bar presence of brush surface in contact with the commutators;
- remove dust that can cause a short circuit between brush holders and frame; and
- check lead connections to the brush holders. Loose connections can cause overheating.

Look for obvious commutator problems:

- any condition other than a polished, brown surface under the brushes indicates a problem. Severe sparking causes a rough blackened surface. An oil film, paint spray, chemical contamination and other abnormal conditions can cause a blackened or discoloured surface and sparking. Streaking or grooving under only some brushes or flat and burned spots can result from a load mismatch and cause motor electrical problems. Grooved commutators should be removed from service. A brassy appearance shows excessive wear on the surface resulting from low humidity or wrong brush grade;
- high mica or high or low commutator bars make the brushes jump, causing sparking; and
- carbon dust, copper foil or other conductive dust in the slots between commutator bars causes shorting and sometimes sparking between bars.

If correcting any obvious deficiencies does not eliminate sparking or noise, look at the less obvious possibilities:

- if brushes were changed before the problem became apparent, check the grade of brushes. Weak brushes may chip. Soft, low abrasive brushes may allow a thick film to form. High friction or high abrasion brushes wear away the brown film, producing a brassy surface. If the problem appears only under one or more of the brushes, two different grades of brushes may have been installed. Generally, use only the brushes recommended by the motor manufacturer or a qualified brush expert;
- the brush holder may have been reset improperly. If the boxes are more than 3 mm from the commutator, the brushes can jump or chip. Setting the brush holder off neutral causes sparking. Normally the brushes must be equally spaced around the commutator and must be parallel to the bars so all make contact with each bar at the same time;
- an eccentric commutator causes sparking and may cause vibration. Normally, concentricity should be within 0.025 mm on high speed, 0.050 mm on medium speed and 0.1 mm on slow speed motors; and
- various electrical failures in the motor windings or connections manifest themselves in sparking and poor commutation. Look for shorts or open circuits in the armature circuit, grounds circuit and in the field winding circuits. A weak inter-pole circuit or large air gap also generates brush sparking.
PROCESS AREA ANALYSIS

The following tips are intended to direct the attention of the process engineer or the mill manager on the often neglected relatively obscure corners of the process flow system. A thorough knowledge of the intricacies associated with it would make processing operation more scientific and extraction rate more profitable. An engineer or for that matter a process supervisor, who take the trouble to grasp the fundamental basics, would be able to perform better than others, who lack the knowledge, provided of course, the infrastructure like the process control laboratory and the process operators are reliable and committed. Let us now look at all the process areas including the hidden areas of the processing plant. Only two of them playing a significant role, are highlighted: (a) process control dilemma and (b) practical actions for controlling product losses.

Process Control Dilemma

The analysis of samples provides the evidence of whether the processing had been efficient or otherwise. But do they really represent the actual processing? Can any mill engineer honestly declare that his mill laboratory analysis give a good indication of the actual operation of his mill? No matter how accurate the analysis, the result becomes meaningless if the sampling is erratic. Who checks on the sampling and how it is being performed? Do they follow all the guide lines all the time? Let us look at them critically.

Oil Loss in Sterilizer Condensate

The sterilizer condensate flows into the sterilizer condensate pit and from there it is pumped out separately into the final effluent pit. After this no oil is pumped into the process system as it is deemed to be off-quality. How a representative sample is to be taken from this pit is a big question mark as the oil usually floats in the pit but small particles will not rise to the surface. If we take a mixture of samples from the top and the bottom will it be a representative sample? Some mills have solved the problem by pumping the top layer of the condensate oil for press crude oil dilution. Does this mean that there is no more oil loss here? This unethical practice has almost become a regular feature now, encouraged by the lucrative crude palm oil price.

EMPTY FRUIT BUNCHES

It is almost impossible to obtain a representative sample from empty fruit bunches. Here, bunches will have varying degrees of oil content depending on the degree of ripeness and the threshing they are subjected to. The oil loss may vary widely and even can

* Malaysian Palm Oil Board, P. O. Box 10620, 50720 Kuala Lumpur, Malaysia.
reach 1% (% to fresh fruit bunch) but such high figures are usually rejected by the mill as an odd figure. The sampling method is also somewhat odd. Usually one bunch is selected from every 300 bunches moving along the conveyor and if that happens to have absorbed the least oil, the oil loss in empty fruit bunch will be low for a prescribed period of time. This trial is conducted once in every six months or none at all. Those who do not conduct this trial adopt an arbitrary figure close to 0.45% (% to fresh fruit bunch) as a normal value, even though the actual loss could be as high as 0.6% (% to fresh fruit bunch) or even more. Some mills do not consider this as a loss at all, when computing total oil loss to fresh fruit bunch. Empty fruit bunch is like a bloating paper and it really absorbs oil - probably more than any other bunch component - yet the least importance is given to it. This is a vast contrast to the oil absorbed by the nut surface at only 0.08% (% to fresh fruit bunch) for which more attention is given by the process control and the mill management.

It is difficult to give a figure that will reflect the actual oil loss in empty fruit bunches with reasonable degree of accuracy to satisfy a serious process engineer. A simple and practical compromise seems to be to conduct trials at least once a month supervised by the process engineer.

**OIL LOSS IN CYCLONE FIBRE**

Here again the accuracy of sampling can play a role in the accuracy of the results. The samples taken from the bottom of the press are usually oily, while that of the top are dry. The oil loss can vary widely in both samples. The accuracy in such cases will depend on a proper mixing and quartering of samples.

**Practical Actions for Controlling Product Loss**

**Sterilization.** The sterilizer temperature has to remain high, preferably above 140°C for a number of reasons. The mill engineers are fully aware of this. The main reason is not sterilization per se as that will require only 60°C for a few minutes to inactivate lipase but for conditioning the pericarp and nuts for subsequent process activities. The correct terminology for this is pressure cooking.

Admitting 3 barg steam into the sterilizer, while half of it still contains air will not give satisfactory cooking. If for example, it contained one-quarter air and three-quarter steam, the partial pressure of steam, according to Dalton’s Law of Partial Pressure is only 2 barg and the corresponding saturation temperature will be based on 2 barg i.e. 132.9°C instead of 142.9°C expected of steam at 30 barg. The 10° difference is significant in terms of bunch stripability and oil loss.

If serious attention is given to remove as much air as possible from the sterilizer chamber, mills will not have to install double stripping. If bunches are heated to a temperature that is above 140°C, fruits will detach from the bunch without the need for double stripping. Air is continuously released by the bunch, when it is subjected to heating and its evacuation is accomplished by the continuous bleeding of the condensate. Double stripping is akin to fighting consequences rather than the cause.

The clarification tank temperature has to be closed to or above 95°C, if high oil extraction rate is the priority. But unfortunately, at high process temperatures, the DOBI value will drop. A compromise has to be made here. The difference in oil extraction rate can be quite significant when processing at high or low temperatures.

**Pressing.** There is no established data on the effectiveness of the mild steel plate that now seem to have replaced the once popular conical plug, for constraining the free discharge of press cage. In all likelihood, the conical plug could get better results than a flat plate as in the former case the press cake can flare out evenly.

The press feed should not contain too much oil as this will cause the feed to be
slippery. On the other hand, if most of the oil has been pre-extracted, then with low pressing pressures, the remaining oil can be extracted. There is no benefit in increasing the press cone pressure indiscriminately to excessive pressures like 60 - 80 bar with the intention of extracting more oil. What will generally happen is very high nut breakage, which should not be permitted to exceed 15%. In their eagerness to increase the oil extraction rate, some mills resort to even 80 bar cone pressure without any consideration for excessive nut breakage. Considerable oil can be drained off from the digester by installing a good drainage box that works under all conditions.

Using high cone pressure in a press would also cause an increase in the production of solids that in turn will absorb oil. For improving oil separation in the digester, a few fundamentals have to be adhered to. They are (a) the digester must be at least three-quarter full, (b) the temperature must be at least 95°C, (c) the digester tip clearance should be minimum and (d) the inter-blade vertical constraint bars on the inside digester chamber wall must be in place as without which digester will not be effective.

The crude oil ex-press by itself is ready for clarification without any water dilution as at virgin state the moisture level in the crude palm oil is ideal having the least viscosity with ideal separation properties. Dilution is carried out primarily for promoting the flow of crude palm oil through the gutter into the vibrating screens as otherwise it is too thick to flow. This could have been resolved by installing an auger to push it through the gutter but an erratic step was initiated then and to this day it holds good as an integral process step. The current water addition regime is about 41% of the press liquor so that the final oil content in the diluted crude is 39% from the original 55% in crude oil.

The crude oil transportation from the crude oil tank to the clarification tank originally was done using a positive displacement screw pump like Mohno pump. Now almost all mills have shifted to centrifugal pumps because they are cheap and easy to maintain. But its defects, for pumping crude oil, are not well publicized. The churning effect of the centrifugal pump causes the formation of emulsion, which once formed, remains inseparable from one another. That is why, for maximum oil recovery, positive displacement pumps were recommended.

Another equipment that seem to have gone out of fashion is the rotary brush strainer, which has a real function to play. It imparts a shearing force to the sludge so that oil separation in the separator is more efficient. It should not be cut to make rotation friendlier with the chamber as in which case it will not be serving any purpose at all.

**Sludge separator.** Simple logic says that the smaller the nozzles the better oil recovery or inversely when the nozzle size enlarges the oil will tend to rise. The separator also must run full for good oil recovery. This can be done by having a ring type sludge header that can supply feed to all separators equally so that no separator will be subjected to partial starvation. These are reasonably well established factors which most millers are likely to be well-versed.

Apart from the above, it is important to recognize the volume of sludge that the sludge separators are required to handle. If the oil losses ex-sludge centrifuge is x%, it will not change if the sludge feed is diluted excessively or otherwise, i.e. if 100 litres of sludge is fed into the separator and the oil loss in the discharge outlet is 0.6%, it will remain the same, if the sludge is diluted 100% and the volume became 200 litres. In the former case, the oil losses will be 0.6 litre and in the latter case 1.2 litres. By excessive dilutions, the % oil retained by the waste water is not reduced. Hence, dilution actually promotes oil loss.
KERNEL LOSSES

The low tension dust separator or the LTDS as it is popularly known can contribute significantly towards the loss of kernel, simply because the separating velocity of the separating column is set erratically and no one has the equipment to measure it. The mill only has to make an opening in the ducting to insert the measuring instrument that can give the velocity of air flow within the column that ranges from 12.5 to 15 m s\(^{-1}\). By careful adjustments, the optimum velocity suitable for the cracked mixture could be selected by adjusting the throat area of the separating column.

This exercise should be carried out on a routine basis so that there is no deviation of separating velocity for prolonged periods of time as the losses could then be significant. At least there should be a weekly velocity monitoring instead of the present once in a life time measurement and this can be done and recorded by the process assistant or the plant operator. The throat velocity can vary due to many reasons like fan blade erosion, accumulation of fibre inside the ducting of the chute or even a puncture along the product flow line. The measurement will throw some light on any of the defects that could have developed during processing due to one reason or other. As the gains far outweigh the investment cost of RM 600 to RM 800 for the purchase of this equipment, millers are encouraged to consider the purchase of such equipment.

Nut Losses in Cyclone Fibre

It is common to see small nuts being lifted and carried along with the cyclone fibre. While it may not be possible to prevent the flow of all nuts, considerable control of this loss can be achieved if the lifting velocity at the separating column is maintained at an optimum level, to cater for free kernel and large or medium pieces of shell to be held in suspension under the action of the induced draft fan. The normal lifting velocity is about 12 m s\(^{-1}\) but may vary depending on the size of nuts. This optimum velocity has to be established by trial and error, guided by the free kernel and small nut losses in cyclone fibre and may have to be re-established again, preferably on a yearly basis. Therefore, it is not a waste to purchase the very useful velocity measuring device.

The Four-stage Winnowing Column - Dry Separation System

The MPOB initiated dry separation system, now undergoing intensive development work for perfecting the equipment and optimizing process parameters, has to depend a great deal on the optimum velocities at many critical points, where separation will take place. Mills using this system will gain maximum benefit if they monitor the lifting velocities at all the required points or otherwise kernel losses may take place without detection. The dry separation system is targeted to do away with the production of effluent and all mills in Malaysia are expected to adopt it as it offers many positive benefits including better kernel extraction and zero effluent production that no other system can offer.
ILTEK* has come up with a technique to prevent gums from sticking to pipe interior in physical refining plant using a slurry heater.

**Principle of Operation**

The slurry heater (Figure 1) is specially designed for heating slurry with up to 4% bleaching earth (but you may not use that much earth). The turning of fluid from one channel to the next occurs in chambers built into the removable channel covers. The flow channels can be easily accessed for cleaning by opening the channel cover at both ends of the shell.

In this modified system, incoming crude oil is heated to the temperature of between 50°C and 70°C when food grade phosphoric acid is added and mixed into the oil. At this low temperature, gums will not precipitate.

Activated bleaching earth is next added to the oil before the oil/acid/earth mixture is heated in the slurry heater to the bleaching temperature. When the temperature is raised, the gums are precipitated and at the same time adsorbed the bleaching earth.

The presence of bleaching earth to adsorb the gums at the same time they are formed ensures a thorough removal of the gums. The reduction of gums in the oil increases the stability of the refined oil, and obviates the problem of gums fouling-up pipes and heat exchanger surfaces.

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Mongana Basics: Part 16 - Study of the Quality and Characteristics of Oil**

N Ravi Menon*

**EFFECT OF MOISTURE**

This has been studied on samples of oil stored in sealed tubes. It is virtually impossible in that case to determine the value of the reaction constant \( k \) because a plot of logarithm of acidity against time leads to curves having their concavity towards the \( t \) axis. The apparent rate of the reaction decreases very quickly as the reaction proceeds. Furthermore, aberrant results are recorded frequently owing to the very small amounts of moisture to be determined. A few results are gathered in Table 1. [Note: Please note that \( k \) = reaction constant, \( A = \% \text{FFA} \), \( t = \text{time} \) (generally expressed in number of 10 days each) as defined in part 15 of the Palm Oil Engineering Bulletin Issue No. 89.]

In order to find out whether the stabilization obtained by dehydration was governed by the free fatty acid content of oil, samples of oil with different levels of acidity were dried by bubbling of nitrogen and were stored in sealed flasks at 58°C. It was observed that the hydrolysis reduces significantly less as the moisture content decreases. No equilibrium is reached; the hydrolysis proceeds until all the moisture has been taken up. The inhibition is therefore proportionately more important for oil with high acidity than for oil with low acidity (Tables 2 and 3).

In the experiments described above, oils with moisture content 0.10% to 0.11% were used. The inhibition is consequently very marked.

It may be useful to know from what level of moisture content, this inhibition takes place. To that end, the comparison was made between the acidification of two samples of oil saturated with moisture. One was continuously brought back to saturation whilst no water was added to the other.

It is rather difficult to pinpoint the time at which the inhibition starts, at least for low acidity oil. It is however, readily noticeable that for a moisture content of the order of 0.16%, the hydrolysis undoubtedly slows down. If the inhibition is described as the ratio of the reaction rates in dehydrated and saturated medium respectively, it may be observed that a value of 0.5 is recorded when moisture content is within the range 0.08% to 0.10%. Figures 1 and 2 illustrate the acidification process taking place in the case of oil permanently saturated with moisture and in the case of the same oil saturated at the beginning of the experiment but allowed to dehydrate itself in the course of time.

Oil with free fatty acidity of 1.35% was used in the experiment of Figure 2. Figure 3 pertains to oil at 5.6% free fatty acid.

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** Continued from p. 41 of Palm Oil Engineering Bulletin Issue No. 89.
### TABLE 1. ACIDIFICATION OF PARTIALLY DEHYDRATED OIL

<table>
<thead>
<tr>
<th>Sample number</th>
<th>% moisture</th>
<th>Time (in days)</th>
<th>Final moisture content (calculated)</th>
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<td>2.20</td>
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<td>13</td>
<td>1.140</td>
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### TABLE 2. LOW FREE FATTY ACID (FFA) OIL

<table>
<thead>
<tr>
<th>Time days</th>
<th>% FFA determined by analysis</th>
<th>% FFA calculated for saturated oil</th>
<th>Moisture content found</th>
<th>Calculated from the concentration of FFA</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.98</td>
<td>0.98</td>
<td>0.11</td>
<td>0.11</td>
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<td>214</td>
<td>1.99</td>
<td>10.55</td>
<td>0.5</td>
<td>0.02</td>
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</table>

### TABLE 3. HIGH FREE FATTY ACID (FFA) OIL

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<th>Time days</th>
<th>% FFA determined by analysis</th>
<th>% FFA calculated for saturated oil</th>
<th>Moisture content Found</th>
<th>Calculated</th>
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</thead>
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</table>
Figure 1 gives a plot of the ratio of the speed of acidification of dehydrated and moisture saturated oil versus the moisture content of the oil. Taking into account the lack of accuracy of the moisture content determination, it may be considered that the instantaneous speed of hydrolysis remains constant when moisture content ranges from the saturated limit to approximately half that value.

From that point, the speed of hydrolysis of partially dry oil is described approximately by:

$$\frac{da}{dt} = k \cdot a \cdot c$$

where $c = \frac{\text{moisture content}}{\text{solubility of water in oil}}$

In practice, when moisture content is of the order of 0.1%, the process of acidification is hardly noticeable, first, as a result of the slowing down of the hydrolysis reaction and second because the hydrolysis process further reduces the available moisture and therefore the reaction speed.

**Effect of Hydrolysis Inhibitors**

We have seen that the speed of the hydrolysis could be modified in two ways only, either through dehydration (slowing the reaction speed) or through adjunction of acids soluble in the oil (increasing the reaction speed).

It may therefore be stated that the removal of acid from the oil (neutralization or distillation of the fatty acid) should lead eventually to a slowing down of the hydrolysis reaction. The removal of acidity entailed technical difficulties in Congo. The drying of oil, on the contrary, can be arranged at industrial scale using non-sophisticated equipment as has already been shown in the previous sections.

Research has however been undertaken to ascertain whether dehydration was the only practical method of stabilizing the acidity of oil. Since the hydrolysis is an equilibrium reaction, the shift of the equilibrium through the action of primary OH groups has been studied. The inhibition effect of these substances (glycerol, methanol, saccharose) is noticeable but not very marked, whether with or without an excess of moisture (saturated atmosphere). Comparing the inhibiting action of methanol, ethanol and glycerol on the hydrolysis, it has been observed that primary OH groups appeared to be more active than secondary groups. An attempt was therefore made to find substances having primary OH groups but more soluble in oil than glycerol. The mono-substituted derivatives of glycerol of the type mono-butyline are not very active in comparison with glycerol in spite of the increased solubility in oil. Ethylglycol and epichlorhydrine are slightly more active. With a view to increase the solubility of glycerol in the oil, chemicals were prepared.
Figure 2. Hydrolysis of partially dehydrated oil.

Figure 3. Hydrolysis of partially dehydrated oil - continuation from Figure 2.
from glycerol in which one or two function were substituted (formation of epoxy function).

The monoethyl and monobutyl etheroxides of epoxyglycerol appear less active than ethyldglycol or epichlorhydrine. Other derivatives of glycerol were assessed. Among these were diepoxyhexane and glycidol. The latter only exhibits a sharp inhibition effect. The effect goes even further in fact since immediately after its addition to oil, a decrease in the free fatty acid content can be observed as a result of re-esterification.

\[
\begin{align*}
\text{H} - \text{C} & \quad \text{O} \\
\text{H} - \text{C} & \\
\text{Epoxy group}
\end{align*}
\]

The effect of glycerol has not been studied in detail. It has been observed that it acts through simple esterification of the primary OH group without splitting of the epoxy bridge.

It appears to be the most interesting of the additional products not only because of its activity but also because it is simply a product of dehydration of glycerol. To some extent therefore, its use does not introduce an abnormal constituent into the oil. Glycidol is prepared through the action of metallic sodium on glycerol monochlorhydrate in the presence of ordinary ether. The reaction is as follows:

\[
\begin{align*}
\text{CH}_2\text{Cl} & \quad \text{CH}_2 & \quad \text{O} \\
\text{CHOH} + \text{Na} & \quad \text{CH} \\
\text{CH}_2\text{OH} & \quad \text{CH}_2\text{OH}
\end{align*}
\]

The chemical acts on oil of any acidity and at the rate of 0.5%, its effect is sharp.

**Mechanism of Hydrolysis**

It has been pointed out the naphtyl sulphonic acid possesses an autocatalytic action more intense than the fatty acids derived from the oil itself. Since that acid is stronger than the fatty acids it can be assumed with a reasonable degree of probability that the reaction is of the ordinary acid catalytic type but it occurs in the lipid phase.

The catalytic hydrolysis of esters is considered as a chain reaction, which features the fixation of a H⁺ ion, the formation of oxonium. This in turn decomposes into carbonium ion and a free alcohol radical. The carbonium ion yields a fatty acid after fixation of one molecule of water and the release of H⁺ ion.

\[
\begin{align*}
R' - \text{C} - \text{O} & + \text{H}^+ \rightarrow R' - \text{C} - \text{O} - \text{R} \\
\text{ester} & \quad \text{proton} & \quad \text{oxonium}
\end{align*}
\]

\[
\begin{align*}
R' - \text{C} & + \text{ROH} \rightarrow R' - \text{C} - \text{OH} + \text{ROH} \\
\text{oxonium} & \quad \text{carbonium} & \quad \text{alcohol}
\end{align*}
\]

\[
\begin{align*}
R' - \text{C} - \text{OH} & + \text{H}_2\text{O} \rightarrow R' - \text{C} - \text{O} - \text{H}^+ \\
\text{carbonium} & \quad \text{acid} & \quad \text{proton}
\end{align*}
\]

The above hydrolysis reaction appears to follow a monomolecular autocatalytic pattern. It has not been possible to establish a relationship between the moisture content and the rate of hydrolysis. It is highly probable that the slowest part of the reaction, which governs the overall reaction rate, is the decomposition of oxinium into carbonium, the latter becoming hydrated and then releasing a H⁺ ion. It would be necessary to accept the fact that, at least within a certain range, the degree of dissociation of the free fatty acids dissolved in oil remains more or less steady. This would explain why the rate of reaction constant does not appear to the markedly affected by the acidity.
**SUMMARY**

The hydrolysis of oil in the presence of an excess of water exhibits the characteristics of an autocatalytic reaction. It is not enzymatic. The reaction proceeds in homogeneous phase at the expense of the water dissolved in oil. The reaction is monomolecular, the limiting factor being probably the decomposition of the oxonium ion. However, when the dissolved moisture content falls below the half saturation mark, the reaction rate slows down considerably. In practice, it may be considered that oil with moisture content less than 0.10% does not acidify to a significant extent. Total stability can however be achieved only with complete dehydration.

The impurities of the oil do not have any effect on the hydrolysis. They may trigger the reaction indirectly if they act as a culture medium for lipolytic micro-organisms.

The effect of numerous compounds has been examined. Only acids soluble in oil catalyze the hydrolysis. At equal concentration, low molecular weight fatty acids have a greater effect than those with long chain. The effect of temperature is very marked. This is not specific to palm oil.

Some compounds can be esterified by the fatty acids of the oil. Glycidol was observed to be the most active.

From the practical point of view, only the inhibition of the hydrolysis through dehydration is of great interest. It is however, necessary to remark that low initial acidity entails a marked drop in the rate of the hydrolysis reaction.

**BIOCHEMICAL ACIDIFICATION**

**General**

It was been observed that, in some instances, the acidity of palm oil increased faster than predicted by the autocatalytic law. In mills as well as on reception of oil at Leopoldville, cases of abnormal acidification of purified oil have been recorded. Furthermore, it has been noted that the addition of rotten kernels oil to palm oil or palm kernel oil led to abnormal increases in acidity particularly when an extract had been added.

The laboratory examination of these oils showed that abnormal acidification is stopped when oil is sterilized at a temperature of 90°C; 60°C was even sufficient sometimes. In those cases, bromoacetates have an inhibiting action, which may be explained by the fact that these compounds act on micro-organisms and not on enzymes. The processes of fast acidification often follow an irregular pattern. They are usually not easily reproducible because the degree of dispersion of the aqueous phase affects the reaction mechanism, the enzymatic or microbiological acidification being necessarily a reaction taking place in a heterogeneous medium.

Instances of typical biochemical acidification have been observed on crude oil stored at ambient temperature. *Table 5* gives an idea of the intensity of the occurrence.

If hydrolysis had been of autocatalytic origin, the acidification process would not have exceeded 0.1% free fatty acid over 21 days (storage at ambient temperature that is approximately 28°C).

In the above cases, the sterilization of crude oil followed by storage under sterile conditions stop further acidification. This shows beyond doubt that the increase in free fatty acid is due to a thermolabile factor. Moreover, filtering the crude oil also stops the process (separation of impurities). It may therefore be concluded that this factor is active only in a richer and more balanced medium than just oil and water. The factor can only be a lipase derived from the growth of lipolytic micro-organisms.
Search for Lipolytic Micro-organisms

Among culture media listed in technical publication, the following were selected for various reasons:

- a standard gelatine medium, without sugar, containing 1% of tributyrin emulsified by means of 1.5% tween 80; and
- a slightly modified Nile Blue gelatine medium.

The presence of a lipolytic micro-organism is detectable in the former though the occurrence of a light coloured zone around the colony and in the latter through the deep blue colouration assumed by the lipolytic colonies.

A further test based on the hydrolysis of a solution of phenolphthalein dibutyrate is described in technical publications. This test, which has been checked on Pseudomonas fluorescens has yielded aberrant results when used on the aqueous phase of the crude oil and on slurries of fresh fruit prepared in a turbo-mixer.

Another method which consists in shaking purified oil with a culture of micro-organisms has not led to significant results.

Finally, a method which gives particularly significant results consists in inoculating sterile crude oil from a continuous press with the strain to be tested. The test was carried out on approximately 20 organisms isolated from infected crude oil. The micro-organisms included four yeasts, four spore bacteria, eight non-spore bacteria and eight fungi.

Of the 12 bacteria strains, only three (probably of the same species) gave a positive test with Nile Blue culture medium and hydrolysed the phenolphthalein dibutyrate. They appear unable to proliferate on crude oil or to hydrolyse it. In view of the almost certain presence of lipase and of these bacteria in oil which acidify rapidly, it would have been desirable to study the latter in more detail.

However, one of the isolated fungi is particularly remarkable with regard to its lipolytic activity. On potato agar medium it appears in the form of slightly woolly white colonies, which branch out radially from a focal point.

In the Mongana liquid medium, the fungus produces a veil like colony, a ring and a blur. The microscopic examination shows radially growing filaments, which were grouped in the early stage but which sporulated rapidly on ageing. The spores fall out and in the free state, look very much like large size yeasts.

The colony did not assume a blue colour in the Nile Blue culture medium. The phenolphthalein dibutyrate test is positive and the inoculation of sterile crude oil gives rise

---

**TABLE 5. ACIDIFICATION OF CRUDE OIL IN THE COURSE OF TIME.**

**STORAGE AT AMBIENT TEMPERATURE (28°C)**

<table>
<thead>
<tr>
<th>Time</th>
<th>Low pressure press</th>
<th>High pressure press</th>
<th>Centrifuge</th>
<th>Digester</th>
<th>Press</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initially</td>
<td>2.82</td>
<td>2.75</td>
<td>3.05</td>
<td>2.81</td>
<td>3.53</td>
</tr>
<tr>
<td>After 3 days</td>
<td>3.29</td>
<td>2.89</td>
<td>2.93</td>
<td>3.46</td>
<td>3.83</td>
</tr>
<tr>
<td>After 7 days</td>
<td>3.41</td>
<td>3.05</td>
<td>3.62</td>
<td>4.28</td>
<td>6.11</td>
</tr>
<tr>
<td>After 14 days</td>
<td>4.43</td>
<td>5.17</td>
<td>3.89</td>
<td>5.06</td>
<td>7.28</td>
</tr>
<tr>
<td>After 21 days</td>
<td>6.28</td>
<td>7.53</td>
<td>4.71</td>
<td>5.66</td>
<td>7.77</td>
</tr>
</tbody>
</table>
to rapid acidification which does not leave the slightest doubt on the role of the fungus in similar cases encountered under routine conditions. For instance, a sample of crude oil with initial 1.6% acidity was inoculated and showed an increase to 7% free fatty acid after three days and 19.8% free fatty acid after 21 days. This experimental acidification has been repeated several times. The Commonwealth Mycological Institute, Surrey, England, identified the fungus as Geotrichium Candidum Link.

This fungus which was isolated from a batch of crude oil exhibiting proneness to rapid acidification was identified in petri dishes and isolation plates on which were grown fungi collected from the inner side of the roof over an oil clarification station. The roof had been soiled by projections of crude oil from a settling tank. The oil produced in that particular factory (Mombessa) often underwent abnormally intense acidification (2% during transport from factory to Leopoldville).

Another yellow fungus (Mucor) which turns black on sporulation is slightly lipolytic. It was isolated from mouldy fruit and appears to be a very common infestation in Mongana. A slight acidification of crude oil was shown to take place. The seeded oil had an initial free fatty acid of 1.6%. The acidity had increased to 3.4% after 21 days storage at ambient temperature. Its lipolytic activity is therefore considerably lower than that of the Geotrichium strain.

**Orange Fungus of the Empty Bunches**

The fungus which covers sterilized empty bunches exposed to air for a few days with a powdery orange coloured layer is well-known. The growth starts on the spikelets. A sample was isolated on gelatin medium containing 10% of milk serum. The proliferation is more rapid at 37°C than at 25°C. After 12 hr at 37°C, there appears a white mycelium without sporangium. After 21 hr at that temperature, there appeared ramified, white, non-separated macroconidies. The macroconidies grow in a direction perpendicular to the culture medium. Their microscopic appearance is that of white flakes. When the culture medium is exhausted, the spores assume a bright orange colouration.

Acidification tests were carried out by introducing fungus coloured pieces of empty bunches into oil and also by stirring an aqueous extract of culture into the oil. The fungus has no lipolytic activity.

**Lipase of the Fruit**

The lipase of the oil palm fruit is highly active but it has not been possible to prepare an extract of the fruit pulp with marked hydrolyzing characteristics. As was stated in the section Search for Lipolytic Micro-organisms, the pulp extract does not hydrolyse the phenolphthalein dibutyrate. Even the thorough mixing of bits of pulp and purified oil in a turbo-mix does not trigger hydrolysis of the latter.

**CONCLUSION**

It is absolutely certain that acidifications of microbiological origin can occur in oil mills. Crude oil is particularly prone to that process but in all probability inadequately clarified oil can equally be affected.

In practice, the clarification of crude oil must be carried out as soon as possible after extraction. The oil should be sterilized through heating to a temperature equal or higher than 90°C after clarification and purification. That level of temperature is sufficient to destroy micro-organisms and the lipase they produce.

Finally, oil should be stripped of non-fatty substances normally found in all crude oils (pectins and other carbohydrates), inclusive of water, without which micro-organisms cannot proliferate.
Question 56/90

According to MPOB’s requirement, a mill boiler should be able to supply steam (t hr⁻¹) equivalent to a minimum of 60% of the mill processing capacity (t hr⁻¹). As these figures are based on a conventional boiler pressure of 21 barg, what will be the required or MPOB’s revised steam ratio, if the boiler pressure is 30 barg as is the trend now in some new mills.

- Applicants for mill expansion.

A number of mill engineers, including some with mechanical engineering degrees, seem to be a little confused about this. Let us clear this once and for all. In a conventional mill, boilers steaming at 21 barg pressure admit the steam to a non-condensing turbine and exhaust it at 3 barg, the required process steam pressure, after the steam has undergone isentropic expansion in the turbine. The process can be represented as a vertical line in a temperature or heat-entropy chart. The work done by the steam is represented by the area under the cycle diagram. The supplied steam may either be saturated or super heated, as the case may be, but the exhaust steam pressure and temperature remains the same with slight alterations in the dryness fraction caused by the properties of the different state points of the steam in boilers with such provision.

Figure 1 represents the temperature entropy diagram of the two cases of isentropic expansion of steam in a turbine with steam entering at two different pressures but with the same mass flow. At point 1, the steam at 30 barg-pressure makes its entry into the turbine, while at point 2, the steam at 21 barg enters the steam turbine. W1 and W2 are the work done by the two cycles being the areas under the respective expansion curves. The conditions of the steam after isentropic expansion are the same for both, in terms of temperature and pressure except for dryness fraction, which is seen to be better due to its initial super heat in the higher pres-

![Figure 1. Temperature entropy diagram for a palm oil mill boiler turbine.](image_url)
What are the typical storage conditions and storage facility for palm oil mills?
- Queries to MPOB.

The requirements are summarized in one of the recently drafted five Codes of Practice (COP) organized by Dr Ainie Kuntom of MPOB. There is also an MPOB publication comprising 13 pages that gives all the relevant details regarding storage of palm oil in mills, transportation, shipping, rails etc. Nevertheless, I shall strive to highlight some of them in Table 1.

What is the minimum and maximum storage unit size (in tonnes)?
- Queries to MPOB.

The capacity for different types of oils are given in Table 2.

How long is the period for which one batch of palm oil stored in the above tanks is used up (months or years).
- Queries to MPOB.

The Mongana Research Report suggests the following criteria based on peroxide values (Table 3).

The exact period is not spelled out by any authority but I would say from milling experience that a maximum of nine months (subject to the free fatty acid being above 3.5%) may be considered a reasonable period for category 1 and three months for category 2 in Table 3 in the absence of any other data. Trials by Dr Tan Yew Ai of MPOB, indicated that after a storage period of even two years, the quality of crude palm oil deteriorated rapidly.

Long-term storage of all oils should be at ambient temperatures and heating should
TABLE 1.

<table>
<thead>
<tr>
<th>Quality</th>
<th>Dirt should be less than 0.015% and moisture less than 0.2%.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating steam</td>
<td>Below 0.15 bar pressure, with thermostat control.</td>
</tr>
<tr>
<td>Temperature</td>
<td>Between 45°C to 55°C. This is to prevent disproportionate volume of olein being dispatched and the build-up of strain. Rate of temperature rise should not exceed 5°C in 24 hr. The temperature to be maintained using an automatic control system. Aeration must be avoided.</td>
</tr>
<tr>
<td>Tank coating</td>
<td>Bottom 3 m with epoxy, ceramic, linseed oil etc.</td>
</tr>
<tr>
<td>COP filling</td>
<td>Feed pipe to extend to tank bottom to prevent splashing.</td>
</tr>
<tr>
<td>Heating coil</td>
<td>Surface area about 0.1 m² t of crude palm oil.</td>
</tr>
<tr>
<td>Tank cleaning</td>
<td>Once in six months.</td>
</tr>
<tr>
<td>Bottom ‘foot’</td>
<td>Drain daily to prevent build up of lipolytic micro-organisms.</td>
</tr>
<tr>
<td>Construction</td>
<td>Vertical, circular cross-section tank with self-supporting fixed roof, preferably convex in shape. Tall narrow tanks are preferred to minimize exposed surface area. Tank bottom to be conical or sloped to be self-draining. Material: mild steel. No copper brass or bronze fitting to be in contact with crude palm oil.</td>
</tr>
</tbody>
</table>

TABLE 2.

<table>
<thead>
<tr>
<th>Crude liquid oil tank farms in mill, export etc.</th>
<th>1 000 to 5 000 t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude non-liquid oils and refined oils</td>
<td>500 to 2 000 t</td>
</tr>
<tr>
<td>High melting fats e.g. palm stearin, tallow, hydrogenated oil</td>
<td>500 to 1 000 t</td>
</tr>
<tr>
<td>Fatty acid distillates or acid oil (depends on turnover)</td>
<td>500 or above</td>
</tr>
</tbody>
</table>

TABLE 3.

<table>
<thead>
<tr>
<th>Peroxide value</th>
<th>Type of storage</th>
<th>Period (subjective)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 3</td>
<td>Can be stored</td>
<td>9 months (free fatty acid above 3.5%)</td>
</tr>
<tr>
<td>3 - 6</td>
<td>Can be stored for limited period</td>
<td>3 months</td>
</tr>
<tr>
<td>7 - 10</td>
<td>Must be refined immediately</td>
<td>1 week</td>
</tr>
</tbody>
</table>

be completely turned off. Heating rate must not exceed 5°C per 24 hr duration to minimize the damage to the crude palm oil. If for example, the temperature of the crude palm oil has been 32°C-40°C during storage and if we want to dispatch it, we have to heat it up for three days to get the dispatch temperature of 55°C. The steam pressure also should not exceed 1.5 bar to prevent localized overheating. Stirring using side agitators or recirculation from the tank bottom to the top but with the pipe extending to the bottom are also recommended to avoid local overheating. Blanketing with inert gases also is used for preventing aeration, while in storage or during shipping.
**Oil Loss as a % to FFB - Quick and Ready Reckoner**

<table>
<thead>
<tr>
<th>Oil loss on wet sample</th>
<th>Fibre to FFB ratio</th>
<th>EFB to FFB ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>1.5</td>
<td>0.17</td>
<td>0.18</td>
</tr>
<tr>
<td>1.6</td>
<td>0.18</td>
<td>0.19</td>
</tr>
<tr>
<td>1.7</td>
<td>0.19</td>
<td>0.20</td>
</tr>
<tr>
<td>1.8</td>
<td>0.20</td>
<td>0.22</td>
</tr>
<tr>
<td>1.9</td>
<td>0.21</td>
<td>0.23</td>
</tr>
<tr>
<td>2.0</td>
<td>0.22</td>
<td>0.24</td>
</tr>
<tr>
<td>2.1</td>
<td>0.23</td>
<td>0.25</td>
</tr>
<tr>
<td>2.2</td>
<td>0.24</td>
<td>0.26</td>
</tr>
<tr>
<td>2.3</td>
<td>0.25</td>
<td>0.28</td>
</tr>
<tr>
<td>2.4</td>
<td>0.26</td>
<td>0.29</td>
</tr>
<tr>
<td>2.5</td>
<td>0.28</td>
<td>0.30</td>
</tr>
<tr>
<td>2.6</td>
<td>0.29</td>
<td>0.31</td>
</tr>
<tr>
<td>2.7</td>
<td>0.30</td>
<td>0.32</td>
</tr>
<tr>
<td>2.8</td>
<td>0.31</td>
<td>0.34</td>
</tr>
<tr>
<td>2.9</td>
<td>0.32</td>
<td>0.35</td>
</tr>
<tr>
<td>3.0</td>
<td>0.33</td>
<td>0.36</td>
</tr>
<tr>
<td>3.1</td>
<td>0.34</td>
<td>0.37</td>
</tr>
<tr>
<td>3.2</td>
<td>0.35</td>
<td>0.38</td>
</tr>
<tr>
<td>3.3</td>
<td>0.36</td>
<td>0.40</td>
</tr>
<tr>
<td>3.4</td>
<td>0.37</td>
<td>0.41</td>
</tr>
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<td>3.5</td>
<td>0.39</td>
<td>0.42</td>
</tr>
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<td>3.6</td>
<td>0.40</td>
<td>0.43</td>
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<tr>
<td>3.7</td>
<td>0.41</td>
<td>0.44</td>
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<td>3.8</td>
<td>0.42</td>
<td>0.46</td>
</tr>
<tr>
<td>3.9</td>
<td>0.43</td>
<td>0.47</td>
</tr>
<tr>
<td>4.0</td>
<td>0.44</td>
<td>0.48</td>
</tr>
<tr>
<td>4.1</td>
<td>0.45</td>
<td>0.49</td>
</tr>
<tr>
<td>4.2</td>
<td>0.46</td>
<td>0.50</td>
</tr>
<tr>
<td>4.3</td>
<td>0.47</td>
<td>0.52</td>
</tr>
<tr>
<td>4.4</td>
<td>0.48</td>
<td>0.53</td>
</tr>
<tr>
<td>4.5</td>
<td>0.50</td>
<td>0.54</td>
</tr>
<tr>
<td>4.6</td>
<td>0.51</td>
<td>0.55</td>
</tr>
<tr>
<td>4.7</td>
<td>0.52</td>
<td>0.56</td>
</tr>
<tr>
<td>4.8</td>
<td>0.53</td>
<td>0.58</td>
</tr>
<tr>
<td>4.9</td>
<td>0.54</td>
<td>0.59</td>
</tr>
<tr>
<td>5.0</td>
<td>0.55</td>
<td>0.60</td>
</tr>
</tbody>
</table>

Note: The above table is not intended to replace your normal process control procedures and calculations.
MODELLING FLOWERING AND SEASONAL YIELD CYCLES OF OIL PALM

Simulation models for teaching and research

OPFLSIM 3.0

Developed primarily as an aid to research and teaching, the OPFLSIM (Oil Palm Flowering Simulator) version 3 software package has been developed under funding by the Malaysian Palm Oil Board (MPOB) as a tool to investigate the complex processes underlying flowering and yield cycles in oil palm. The software is accompanied by a Technical Manual and Users’ Guide which provides full details of the basis for the model and its construction, together with numerous examples of program output.

A CD-ROM containing the software is supplied with each copy of the Manual while the program may also be downloaded at no extra charge by subscribers to the MPOB Palmoilis website (http://palmoilis.mpob.gov.my).

This new version is an update of two previous models, all of which are based on endogenous feedback loops postulated to regulate inflorescence and fruit bunch production. The new model includes several extra features including inbuilt interactions between bunch number and mean bunch weight, and optional responses to external stress factors, and is contained in a C# program within a main Windows-compatible interface.

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The event will chart the way forward for the industry in the world’s oils and fats economy. It will also be a platform for participants to interact and share information in all areas pertaining to the oil palm industry.

The Congress will also showcase a grand exhibition of the palm oil industry. With a total floor space of more than 2000 m² and 200 booths, you can expect to see a charade of new technologies and information to increase the productivity of your business.

Technical tours to plantation, palm oil mill, refinery, oleochemical plant and R & D facilities will also be arranged. A golf tournament is also in store for participants and golfing enthusiasts.

Congress Registration Fee

<table>
<thead>
<tr>
<th>Participant Type</th>
<th>RM</th>
<th>EURO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Bird (before 30 June 2009)</td>
<td>2,200</td>
<td>480</td>
</tr>
<tr>
<td>Normal (after 30 June 2009)</td>
<td>2,500</td>
<td>550</td>
</tr>
<tr>
<td>Poster presenters &amp; Students</td>
<td>1,250</td>
<td>275</td>
</tr>
</tbody>
</table>

MPPOB Licensees

<table>
<thead>
<tr>
<th>Licensee Type</th>
<th>RM</th>
<th>EURO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Bird (before 30 June 2009)</td>
<td>2,000</td>
<td>440</td>
</tr>
<tr>
<td>Normal (after 30 June 2009)</td>
<td>2,200</td>
<td>480</td>
</tr>
</tbody>
</table>

3% discount for group registration of 6 and more persons after the early bird period

Exhibition Fee (varies with location)

<table>
<thead>
<tr>
<th>Exhibition Fee</th>
<th>RM</th>
<th>EURO</th>
</tr>
</thead>
<tbody>
<tr>
<td>10,500/</td>
<td>2,310/</td>
<td></td>
</tr>
<tr>
<td>11,500/</td>
<td>2,530/</td>
<td></td>
</tr>
</tbody>
</table>

For more information, please contact: pipoc2009@mpob.gov.my

Organized by: Malaysian Palm Oil Board (MPPOB)
Ministry of Plantation Industries and Commodities Malaysia
www.mpob.gov.my
ADVERTISEMENT

Due to the increased cost of printing, the advertisement rate for 2008 is RM 700 per issue for an A4 size page of black and white, whereas the cost for colour is RM 900. One year of complimentary vendor’s list advertisement is given for every one page A4-size colour or black & white advertisement. Advertisers are required to submit to us either their own black and white artwork or colour separation films. Cheque should be made payable to the ‘Malaysian Palm Oil Board’. If you have any queries, please contact the following at MPOB.

Tel: 03-87694400  Fax: 03-89262971

Dr. Lim Weng Soon  ext: 4406  •  N. Ravi Menon  ext: 4467  •  Lim Soo Chin  ext: 4676
E-mail: milleng@mpob.gov.my

Advertising Schedule for MPOB Palm Oil Engineering Bulletin

<table>
<thead>
<tr>
<th>Issue</th>
<th>Quarter</th>
<th>Deadline for Registration</th>
<th>Deadline for Submission of Artwork</th>
</tr>
</thead>
<tbody>
<tr>
<td>91</td>
<td>Apr - June 2009</td>
<td>30 Apr 2009</td>
<td>31 May 2009</td>
</tr>
<tr>
<td>94</td>
<td>Jan - Mar 2010</td>
<td>30 Jan 2010</td>
<td>28 Feb 2010</td>
</tr>
</tbody>
</table>

REPLY-SLIP

Dr. Lim Weng Soon/Ir. N. Ravi Menon
Engineering and Processing Division
Palm Oil Engineering Bulletin
MPOB
6, Persiaran Institusi
Bandar Baru Bangi
43000 Kajang, Selangor

PALM OIL ENGINEERING BULLETIN ADVERTISEMENT – FULL PAGE ADVT.

1. We confirm our intention to advertise in the MPOB Palm Oil Engineering Bulletin.

<table>
<thead>
<tr>
<th>Company:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address:</td>
</tr>
<tr>
<td>E-mail:</td>
</tr>
<tr>
<td>Tel. No.:</td>
</tr>
<tr>
<td>Fax No.:</td>
</tr>
<tr>
<td>Contact Person:</td>
</tr>
<tr>
<td>Issue No.:</td>
</tr>
</tbody>
</table>

2. The artwork is attached/will be sent on ______________________ for your further action.

3. Please find enclosed *crossed cheque No.: ______________________ for RM ______________________ ( ______________________ ) being payment for the advertisement fee.

4. Thank you.

______________________________  ______________________________
(Signature and Date)            (Company chop)
Following a decision by the Editorial Board to further increase the role of Palm Oil Engineering Bulletin to serve the industry better, a new addition called Palm Oil Mill Vendor’s List has been introduced similar to Telekom Yellow Pages to assist mill engineers to know where to source materials or services pertaining to the industry. In order to make this useful, we need the co-operation of the mill engineers/managers to persuade their vendors to advertise in the Vendor’s List for a nominal fee of RM 100/year (four issues). If you have any queries, please contact the following at MPOB.

Tel: 03-87694400  Fax: 03-89262971

Ir. Ravi Menon ext. 4467 or e-mail: nravi@mpob.gov.my
Ms. Lim Soo Chin ext. 4676 or e-mail: milleng@mpob.gov.my

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REPLY SLIP

Dr. Lim Weng Soon/Ir. N. Ravi Menon
Engineering and Processing Division
Palm Oil Engineering Bulletin Advertisement
MPOB, 6, Persiaran Institusi, Bandar Baru Bangi, 43000 Kajang, Selangor, Malaysia.

We wish to advertise in the MPOB Palm Oil Engineering Bulletin Vendor’s List

<table>
<thead>
<tr>
<th>Company:</th>
<th>Issue No.:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact Person:</td>
<td>H/P:</td>
</tr>
<tr>
<td>Address:</td>
<td></td>
</tr>
<tr>
<td>E-mail:</td>
<td>Tel:</td>
</tr>
</tbody>
</table>

Please find enclosed a crossed cheque No.: Bank:
for RM: [Ringgit Malaysia]

drawn in favour of MALAYSIAN PALM OIL BOARD

Please select the headings from the list given below (not more than five headings) under which you wish to advertise.

- Air filters/dryers
- Air separators
- Bearings/belts/bushes
- Boiler spares/control/others
- Boiler suppliers
- Bunch crushers
- Biomass/bio-compost/products
- Castings
- Cleaning - general
- Civil engineering
- Condition monitoring
- Control/automation/spares
- Conveyors/chains/elevators
- Consultancy services/certification
- Diesel eng./services/spares
- Dynamic balancing
- Electric motors/systems
- Expansion joints
- Fans
- Fabrication works
- Filter press/materials
- Fluid control system/couplings
- Gaskets/packing materials/seals
- Gear boxes
- Hardware
- Hydraulic systems/services/spares
- Laboratory analysis
- Laboratory equipment
- Lubricants
- Mill machinery/spares
- Miscellaneous
- Nut crackers
- Oil recovery systems
- Palm kernel oil crushing plant
- Pollution control/safety systems
- Pressure vessels
- Pumps/services
- Purifiers
- Renewable energy
- Screw press/parts
- Scrubbers
- Sludge separators/decanters
- Steam turbines/generator/spares
- Sterilizer-parts
- Storage silos
- Vacuum pumps
- Valves/seats
- Water treatment
- Waste water treatment
- Welding equipments
- Weighing machines/spares
- Wheel loaders/spares

Signature: 
Name: 
Date: 

Company chop
From: ________________________________

Address: ________________________________

______________________________

______________________________

Question/Comment:

Signed: ____________________________

Date: ____________________________

(We have enclosed this form to assist you in sending to us any questions or comments)