

CONTINUOUS STERILIZATION OF FRESH FRUIT BUNCHES: A QUALITATIVE AND QUANTITATIVE ASSESSMENT OF ITS CURRENT STATUS

BY

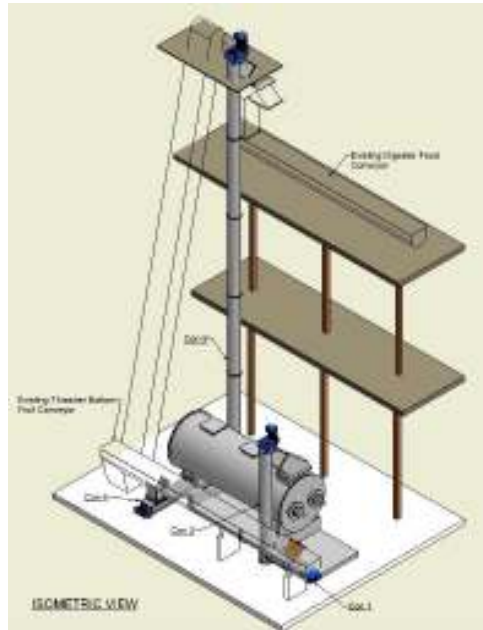


**SIVASOTHY KANDIAH
MALAYSIAN PALM OIL BOARD**

MAIN FEATURES OF THE CONTINUOUS STERILIZATION SYSTEM

- ❖ Continuous and uninterrupted flow of bunches due to use of steam at atmospheric pressure.
- ❖ Consistent product retention time (no short-circuiting and no product accumulation).
- ❖ Bunches are conveyed without being subjected to very high forces.
- ❖ Bunches are pre-heated immediately after crushing to minimize oil quality deterioration.

POST-HEATING OF FRUITS



Advantages

- ❖ Increase in press throughput.
- ❖ Reduction in oil loss.
- ❖ More consistent press performance (less need for operator attention).



SCREENING OF PRESS LIQUOR



The press liquor is more viscous when using the continuous sterilization process and the screening capacity of the typical double-deck vibrating screen is reduced.

POSSIBLE SOLUTIONS TO SCREENING PROBLEM



- ❖ Increase the number of screens used.
- ❖ Modify the clarification process and use a coarser screen.

OER AND KER OF MILLS USING CONTINUOUS STERILIZATION (AVERAGE FOR JANUARY TO MARCH 2010)

<i>Mill</i>	<i>Daerah</i>	<i>Commenced Operation</i>	<i>OER</i>	<i>KER</i>
<i>Melalap</i>	<i>Tenom</i>	<i>2008</i>	<i>23.20</i>	<i>4.55</i>
<i>Ulu Sebol</i>	<i>Kota Tinggi</i>	<i>August 2008</i>	<i>22.13</i>	<i>5.69</i>
<i>Sungai Terah</i>	<i>Gua Musang</i>	<i>November 2005</i>	<i>21.16</i>	<i>6.56</i>
<i>Mill 1</i>	<i>Jelebu</i>	<i>September 2006</i>	<i>21.74</i>	<i>5.33</i>
<i>Pasir Besar</i>	<i>Tampin</i>	<i>February 2005</i>	<i>21.53</i>	<i>5.66</i>
<i>Bukit Puteri</i>	<i>Kuala Lipis</i>	<i>March 2005</i>	<i>21.20</i>	<i>4.28</i>
<i>Kota Bahagia</i>	<i>Rompin</i>	<i>April 2007</i>	<i>21.15</i>	<i>5.55</i>
<i>Mill 2</i>	<i>Ulu Terengganu</i>	<i>April 2008</i>	<i>21.00</i>	<i>5.73</i>
<i>Melur Gemilang</i>	<i>Samarahan</i>	<i>November 2007</i>	<i>21.69</i>	<i>4.37</i>
<i>Balingian</i>	<i>Mukah</i>	<i>December 2006</i>	<i>19.56</i>	<i>3.16</i>

**OER AND KER OF MILLS USING CONTINUOUS STERILIZATION
(cont.) (AVERAGE FOR JANUARY TO MARCH 2010)**

<i>Mill</i>	<i>Daerah</i>	<i>Commenced Operation</i>	<i>OER</i>	<i>KER</i>
<i>Mill 3</i>	<i>Maran</i>	<i>August 2008</i>	<i>23.12</i>	<i>6.18</i>
<i>Mill 4</i>	<i>Johore Bahru</i>	<i>October 2008</i>	<i>21.27</i>	<i>6.16</i>
<i>Mill 5</i>	<i>Rompin</i>	<i>October 2008</i>	<i>19.61</i>	<i>5.50</i>
<i>Mamahat</i>	<i>Pitas</i>	<i>January 2009</i>	<i>22.90</i>	<i>3.40</i>
<i>Sachiew</i>	<i>Miri</i>	<i>June 2009</i>	<i>21.17</i>	<i>5.64</i>
<i>Judan</i>	<i>Mukah</i>	<i>September 2009</i>	<i>19.99</i>	<i>3.94</i>
<i>Mill 6</i>	<i>Jerantut</i>	<i>August 2009</i>	<i>23.12</i>	<i>6.07</i>
<i>Mill 7</i>	<i>Rompin</i>	<i>October 2009</i>	<i>22.79</i>	<i>4.99</i>
<i>Mill 8</i>	<i>Mersing</i>	<i>January 2010</i>	<i>20.06</i>	<i>5.47</i>
<i>Average</i>			<i>21.49</i>	<i>5.17</i>

OER AND KER OF MILLS USING CONTINUOUS STERILIZATION IN INDONESIA

<i>Month</i>	<i>Jak Luay</i>		<i>KED</i>	
	<i>OER</i>	<i>KER</i>	<i>OER</i>	<i>KER</i>
<i>January</i>	25.65	4.94	-	-
<i>February</i>	25.59	5.22	22.50	3.51
<i>March</i>	25.79	5.10	23.57	3.51
<i>April</i>	-	-	24.61	3.63

COMPARISON OF OER & KER OF MILLS IN KELANTAN (AVERAGE FOR JANUARY TO MARCH 2010)

<i>Mill</i>	<i>Daerah</i>	<i>OER</i>	<i>KER</i>
<i>Mill 1</i>	<i>Tanah Merah</i>	<i>20.16</i>	<i>5.54</i>
<i>Mill 2</i>	<i>Kuala Kerai</i>	<i>20.44</i>	<i>4.92</i>
<i>Mill 3</i>	<i>Kuala Kerai</i>	<i>20.03</i>	<i>6.10</i>
<i>Mill 4</i>	<i>Gua Musang</i>	<i>20.43</i>	<i>5.75</i>
<i>Mill 5</i>	<i>Gua Musang</i>	<i>19.10</i>	<i>5.39</i>
<i>Mill 6</i>	<i>Gua Musang</i>	<i>20.38</i>	<i>6.18</i>
<i>Mill 7</i>	<i>Gua Musang</i>	<i>20.97</i>	<i>5.48</i>
<i>Mill 8</i>	<i>Gua Musang</i>	<i>21.88</i>	<i>6.16</i>
<i>Mill 9</i>	<i>Gua Musang</i>	<i>21.70</i>	<i>5.80</i>
<i>Sungai Terah*</i>	<i>Gua Musang</i>	<i>21.16</i>	<i>6.56</i>

* Mill using continuous sterilization process.

COMPARISON OF OER & KER OF MILLS IN TERENGGANU (JANUARY TO MARCH 2010)

<i>Mill</i>	<i>Daerah</i>	<i>OER</i>	<i>KER</i>
<i>Mill 1</i>	<i>Dungun</i>	<i>20.11</i>	<i>6.40</i>
<i>Mill 2</i>	<i>Dungun</i>	<i>19.88</i>	<i>5.65</i>
<i>Mill 3</i>	<i>Kemaman</i>	<i>20.05</i>	<i>5.59</i>
<i>Mill 4</i>	<i>Kemaman</i>	<i>19.97</i>	<i>5.57</i>
<i>Mill 5</i>	<i>Kemaman</i>	<i>18.58</i>	<i>5.32</i>
<i>Mill 6</i>	<i>Kemaman</i>	<i>20.78</i>	<i>5.70</i>
<i>Mill 7</i>	<i>Kemaman</i>	<i>20.48</i>	<i>6.26</i>
<i>Mill 8</i>	<i>Kemaman</i>	<i>20.28</i>	<i>5.83</i>
<i>Mill 9</i>	<i>Kuala Terengganu</i>	<i>20.45</i>	<i>5.31</i>
<i>Mill 10*</i>	<i>Kuala Terengganu</i>	<i>21.00</i>	<i>5.73</i>
<i>Mill 11</i>	<i>Kuala Terengganu</i>	<i>20.26</i>	<i>6.30</i>
<i>Mill 12</i>	<i>Kuala Terengganu</i>	<i>19.77</i>	<i>6.31</i>
<i>Mill 13</i>	<i>Settu</i>	<i>19.97</i>	<i>5.51</i>

* Mill using continuous sterilization process.

COMPARISON OF OER & KER OF MILLS IN NEGERI SEMBILAN (JANUARY TO MARCH 2010)

<i>Mill</i>	<i>Daerah</i>	<i>OER</i>	<i>KER</i>
<i>Mill 1*</i>	<i>Jelevu</i>	<i>21.74</i>	<i>5.33</i>
<i>Mill 2</i>	<i>Port Dickson</i>	<i>18.10</i>	<i>5.66</i>
<i>Mill 3</i>	<i>Port Dickson</i>	<i>20.88</i>	<i>4.87</i>
<i>Mill 4</i>	<i>Seremban</i>	<i>18.35</i>	<i>5.82</i>
<i>Mill 5</i>	<i>Seremban</i>	<i>21.09</i>	<i>5.34</i>
<i>Mill 6</i>	<i>Seremban</i>	<i>21.49</i>	<i>5.10</i>
<i>Mill 7</i>	<i>Tampin</i>	<i>19.66</i>	<i>6.10</i>
<i>Mill 8</i>	<i>Tampin</i>	<i>19.22</i>	<i>5.46</i>
<i>Ladang Pasir Besar*</i>	<i>Tampin</i>	<i>21.53</i>	<i>5.66</i>
<i>Mill 9</i>	<i>Jempol</i>	<i>19.32</i>	<i>6.61</i>
<i>Mill 10</i>	<i>Jempol</i>	<i>21.66</i>	<i>5.14</i>
<i>Mill 11</i>	<i>Jempol</i>	<i>20.09</i>	<i>6.14</i>
<i>Mill 12</i>	<i>Jempol</i>	<i>19.80</i>	<i>5.64</i>
<i>Mill 13</i>	<i>Jempol</i>	<i>22.86</i>	<i>4.92</i>

* Mill using continuous sterilization process.

OER OF NEW CONTINUOUS STERILIZATION MILLS

<i>Mill</i>	<i>2005</i>	<i>2006</i>	<i>2007</i>	<i>2008</i>	<i>2009</i>	<i>Jan. to Mar. 2010</i>
<i>Lad. Pasir Besar</i>	<i>19.98</i>	<i>20.23</i>	<i>20.07</i>	<i>20.32</i>	<i>20.39</i>	<i>21.53</i>
<i>Sungai Terah</i>	<i>21.14</i>	<i>21.57</i>	<i>20.74</i>	<i>20.81</i>	<i>21.06</i>	<i>21.16</i>
<i>Bkt. Puteri</i>	<i>20.94</i>	<i>20.96</i>	<i>20.83</i>	<i>20.29</i>	<i>20.77</i>	<i>21.20</i>
<i>Melalap</i>	<i>22.75</i>	<i>22.58</i>	<i>22.22</i>	<i>21.45</i>	<i>23.88*</i>	<i>23.20*</i>
<i>Melur Gemilang</i>	<i>-</i>	<i>-</i>	<i>19.01</i>	<i>21.22</i>	<i>21.01</i>	<i>21.69</i>
<i>Balingian</i>	<i>-</i>	<i>-</i>	<i>19.13</i>	<i>20.02</i>	<i>20.02</i>	<i>19.56</i>
<i>Mill 1</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>21.82</i>	<i>23.13</i>	<i>23.12</i>
<i>Mamahat</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>21.63</i>	<i>22.90</i>
<i>Sachiew</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>20.58</i>	<i>21.17</i>

* New mill.

KER OF NEW CONTINUOUS STERILIZATION MILLS

<i>Mill</i>	<i>2005</i>	<i>2006</i>	<i>2007</i>	<i>2008</i>	<i>2009</i>	<i>Jan. to Mar. 2010</i>
<i>Lad. Pasir Besar</i>	<i>5.14</i>	<i>5.08</i>	<i>5.00</i>	<i>5.16</i>	<i>5.62</i>	<i>5.66</i>
<i>Sungai Terah</i>	<i>4.94</i>	<i>5.46</i>	<i>5.73</i>	<i>5.87</i>	<i>6.32</i>	<i>6.56</i>
<i>Bkt. Puteri</i>	<i>4.94</i>	<i>4.21</i>	<i>4.11</i>	<i>4.35</i>	<i>4.48</i>	<i>4.28</i>
<i>Melalap</i>	<i>3.76</i>	<i>3.31</i>	<i>3.89</i>	<i>4.04</i>	<i>3.91*</i>	<i>4.55*</i>
<i>Melur Gemilang</i>	<i>-</i>	<i>-</i>	<i>2.90</i>	<i>4.27</i>	<i>4.26</i>	<i>4.37</i>
<i>Balingian</i>	<i>-</i>	<i>-</i>	<i>1.72</i>	<i>3.20</i>	<i>3.09</i>	<i>3.16</i>
<i>Mill 1</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>4.94</i>	<i>5.27</i>	<i>6.18</i>
<i>Mamahat</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>3.24</i>	<i>3.40</i>
<i>Sachiew</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>4.50</i>	<i>5.64</i>

* New mill.

EFFECT OF MILL CONVERSION TO CONTINUOUS STERILIZATION ON OER

<i>Mill</i>	<i>2005</i>	<i>2006</i>	<i>2007</i>	<i>2008</i>	<i>2009</i>	<i>Jan. to Mar. 2010</i>
<i>Mill 1</i>	<i>19.16</i>	<i>19.68</i>	<i>19.55</i>	<i>20.27⁺</i>	<i>20.40</i>	<i>21.27</i>
<i>Mill 2</i>	<i>18.48</i>	<i>18.23</i>	<i>18.81</i>	<i>18.89⁺</i>	<i>19.09</i>	<i>19.67</i>
<i>Mill 3</i>	<i>17.61</i>	<i>17.55⁺</i>	<i>18.81</i>	<i>20.12</i>	<i>21.01</i>	<i>21.74</i>
<i>Mill 4</i>	<i>21.00</i>	<i>21.29</i>	<i>21.41</i>	<i>21.80</i>	<i>22.65⁺</i>	<i>23.12</i>
<i>Mill 5</i>	<i>17.97</i>	<i>18.05</i>	<i>19.66</i>	<i>20.34</i>	<i>20.92⁺</i>	<i>22.79</i>
<i>Mill 6</i>	<i>17.82</i>	<i>19.09</i>	<i>18.37</i>	<i>19.21</i>	<i>20.19</i>	<i>20.06⁺</i>
<i>Judan</i>	<i>19.18</i>	<i>18.60</i>	<i>18.15</i>	<i>18.98</i>	<i>18.98⁺</i>	<i>19.99</i>
<i>Kota Bahagia</i>	<i>20.31</i>	<i>20.38</i>	<i>20.22⁺</i>	<i>20.20</i>	<i>20.75</i>	<i>21.15</i>

+ Mill converted from batch to continuous sterilization.

EFFECT OF MILL CONVERSION TO CONTINUOUS STERILIZATION ON KER

<i>Mill</i>	<i>2005</i>	<i>2006</i>	<i>2007</i>	<i>2008</i>	<i>2009</i>	<i>Jan. to Mar. 2010</i>
<i>Mill 1</i>	5.32	5.08	5.62	5.55 ⁺	5.82	6.16
<i>Mill 2</i>	6.06	5.88	5.74	5.48 ⁺	5.46	5.50
<i>Mill 3</i>	5.18	5.05 ⁺	4.89	4.86	4.98	5.33
<i>Mill 4</i>	5.85	5.37	5.55	5.26	5.32 ⁺	6.07
<i>Mill 5</i>	5.17	5.09	5.07	5.03	5.17 ⁺	4.99
<i>Mill 6</i>	6.06	6.02	5.87	5.56	5.68	5.47 ⁺
<i>Judan</i>	4.16	3.79	4.30	4.47	4.31 ⁺	3.94
<i>Kota Bahagia</i>	5.96	5.62	5.56 ⁺	5.51	5.87	5.55

⁺ Mill converted from batch to continuous sterilization.

EFFECT OF MILL CHANGE ON OER

<i>Mill</i>	<i>2005</i>	<i>2006</i>	<i>2007</i>	<i>2008</i>	<i>2009</i>	<i>Jan. to Mar. 2010</i>
<i>Mill 1</i>	<i>19.11</i>	<i>19.44</i>	<i>19.49</i>	<i>20.42⁺</i>	<i>20.37</i>	<i>21.00</i>
<i>Ulu Sebol</i>	<i>18.28</i>	<i>18.70</i>	<i>18.55</i>	<i>19.99⁺</i>	<i>20.99</i>	<i>22.13</i>

+ Old mill was shut down and FFB processed using a new mill based on continuous sterilization.

EFFECT OF MILL CHANGE ON KER

<i>Mill</i>	<i>2005</i>	<i>2006</i>	<i>2007</i>	<i>2008</i>	<i>2009</i>	<i>Jan. to Mar. 2010</i>
<i>Mill 1</i>	<i>5.36</i>	<i>5.30</i>	<i>5.26</i>	<i>5.63⁺</i>	<i>5.75</i>	<i>5.73</i>
<i>Ulu Sebol</i>	<i>5.67</i>	<i>5.18</i>	<i>5.46</i>	<i>5.58⁺</i>	<i>5.62</i>	<i>5.69</i>

+ Old mill was shut down and FFB processed using a new mill based on continuous sterilization.

STEPS TAKEN TO MAKE CONTINUOUS STERILIZATION SYSTEMS MORE MECHANICALLY ROBUST

- ❖ **The condition of chain, sprockets, scrapers, etc. is checked frequently and defective components replaced if there is any likelihood of it leading to problems.**
- ❖ **By using a chain rated for a much higher load than the normal load, the likelihood of chain breakage is reduced.**
- ❖ **The chain tension is checked and adjusted at least once or twice per week to minimize the likelihood of derailments. In some mills, hydraulic chain tensioners are being used.**
- ❖ **By automating the feeding, the likelihood of breakdowns due to over-feeding is minimized.**
- ❖ **By monitoring the load on the drive motor and shutting down the system if the load exceeds a safe limit, the likelihood of a major breakdown is averted.**
- ❖ **Some mills have installed a spare continuous sterilization system.**

STEPS TAKEN TO MAKE CONTINUOUS STERILIZATION SYSTEMS MORE MECHANICALLY ROBUST

- ❖ **Scraper design has been modified to strengthen it to minimize the likelihood of it breaking when snagged.**
- ❖ **Drive motor location has been changed in some mills from the feed end to the opposite end.**
- ❖ **Quick opening doors have been installed to the sterilizer ends to facilitate routine maintenance.**
- ❖ **Sprocket design has been modified to minimize the likelihood of derailment.**
- ❖ **Additional manholes have been installed, especially to the bottom deck, to facilitate the removal of bunches.**
- ❖ **Feed entry has been modified so that the two chains used by the continuous sterilizer are subjected to approximately equal torque.**

STEPS TAKEN TO MAKE CONTINUOUS STERILIZATION SYSTEMS MORE MECHANICALLY ROBUST



SECOND-GENERATION PALM OIL MILL USING CONTINUOUS STERILIZATION



Judan Palm Oil Mill



Sachiew Palm Oil Mill

Second-generation palm oil mills have incorporated the latest innovations to make continuous sterilization systems more robust and to facilitate maintenance.

SECOND-GENERATION PALM OIL MILL USING CONTINUOUS STERILIZATION



2008 Visit (1 ½ years old)



2010 Visit (3 ½ years old)

Balingian Palm Oil Mill

SECOND-GENERATION PALM OIL MILL USING CONTINUOUS STERILIZATION



PT. KED Palm Oil Mill

BRIEF HISTORY OF CONTINUOUS STERILIZATION SYSTEM IN LADANG PASIR BESAR PALM OIL MILL

<i>Date</i>	<i>Event</i>
<i>February 2005</i>	<i>Mill started operation using roller chain.</i>
<i>July 2005</i>	<i>Switched from roller chain to 14 mm link chain.</i>
<i>October 2007</i>	<i>Switched from 14 mm link chain to 16 mm link chain.</i>
<i>Nov. 2007 - Feb. 2010</i>	<i>12 derailments (1 in 2008, 9 in 2009 & 2 in 2010).</i>
<i>March 2010</i>	<i>Installed new 16 mm link chain.</i>
<i>April - May 2010</i>	<i>No problems.</i>

BRIEF HISTORY OF CONTINUOUS STERILIZATION SYSTEM IN SUNGAI TERAH PALM OIL MILL

<i>Date</i>	<i>Event</i>
<i>November 2005</i>	<i>Mill started operation using roller chain.</i>
<i>January 2007</i>	<i>Switched from roller chain to 14 mm link chain.</i>
<i>September 2007</i>	<i>Switched from 14 mm link chain to KDI roller chain (8 mm side plates).</i>
<i>July 2009</i>	<i>Installed new roller chain (downgraded to 6 mm side plates)</i>
<i>Aug 2009 - April 2010</i>	<i>2 chain breaks.</i>
<i>April 2010</i>	<i>Installed new roller chain (reverted to 8 mm side plates).</i>
<i>April - May 2010</i>	<i>No major problems encountered.</i>

BRIEF HISTORY OF CONTINUOUS STERILIZATION SYSTEM IN BALINGIAN PALM OIL MILL

<i>Date</i>	<i>Event</i>
<i>December 2006</i>	<i>Mill started operation using 14 mm link chain.</i>
<i>April 2008</i>	<i>Disruptions due to chain breaks.</i>
<i>May - June 2008</i>	<i>Switched from 14 mm link chain to 16 mm link chain.</i>
<i>July 2008 - Aug. 2009</i>	<i>No major problems encountered.</i>
<i>August 2009</i>	<i>Installed new 16 mm link chain after derailment.</i>
<i>December 2009</i>	<i>Installed auto-tensioner.</i>
<i>Sept. 2009 - Apr. 2010</i>	<i>No major problems encountered.</i>

BRIEF HISTORY OF CONTINUOUS STERILIZATION SYSTEM IN SACHIEW PALM OIL MILL

<i>Date</i>	<i>Event</i>
<i>June 2009</i>	<i>Mill started operation using 16 mm link chain.</i>
<i>June 2009 – March 2010</i>	<i>No major problems encountered.</i>
<i>April 2010</i>	<i>2 minor breakdowns due to chain derailment. Sprockets were replaced. Expecting to replace the chain after approximately one year.</i>

CONTINUOUS STERILIZATION SYSTEM EXPENDITURES

<i>Mill</i>	<i>Started operation</i>	<i>Period Examined</i>	<i>Total cost (RM)</i>	<i>FFB processed (tonnes)</i>	<i>Cost (RM/t.FFB)</i>
<i>Sungai Terah</i>	<i>Nov. 2005</i>	<i>Jan. 2009 – Apr. 2010</i>	<i>51,947.10</i>	<i>145,442.40</i>	<i>0.36</i>
<i>Lad Pasir Besar</i>	<i>Feb. 2005</i>	<i>Jan. 2008 – Apr. 2010</i>	<i>165,276.00</i>	<i>118,408.00</i>	<i>1.40</i>
<i>Kota Bahagia</i>	<i>Apr. 2007</i>	<i>Jan. 2008 – Apr. 2010</i>	<i>426,875.85</i>	<i>308,094.05</i>	<i>1.39</i>
<i>Ulu Sebol</i>	<i>Aug. 2008</i>	<i>Aug. 2008 – Apr. 2010</i>	<i>148,300.00</i>	<i>294,434.34</i>	<i>0.50</i>
<i>Conventional</i>					<i>1.50-2.50</i>

* Includes labour cost and modifications to continuous sterilization system.

CONTINUOUS STERILIZATION SYSTEM EXPENDITURES (SUNGAI TERAH PALM OIL MILL)

<i>Year</i>	<i>Expenditure (RM)</i>	<i>FFB processed (tonnes)</i>	<i>Cost per tonne (RM/t.FFB)</i>
<i>2007</i>	<i>104,396.48</i>	<i>72,943.22</i>	<i>1.43</i>
<i>2008</i>	<i>16,777.34</i>	<i>105,247.00</i>	<i>0.16</i>
<i>2009</i>	<i>39,610.13</i>	<i>110,065.88</i>	<i>0.36</i>
<i>2010 (up to April)</i>	<i>12,336.97</i>	<i>35,376.52</i>	<i>0.35</i>
<i>Overall</i>	<i>173,120.92</i>	<i>323,632.62</i>	<i>0.53</i>

CONTINUOUS STERILIZATION SYSTEM EXPENDITURES (KOTA BAHAGIA PALM OIL MILL)

<i>Year</i>	<i>Expenditure (RM)</i>	<i>FFB processed (tonnes)</i>	<i>Cost per tonne (RM/t.FFB)</i>
<i>2008</i>	<i>108,195.94</i>	<i>136,797.86</i>	<i>0.79</i>
<i>2009</i>	<i>180,456.02</i>	<i>138,172.76</i>	<i>1.31</i>
<i>2010 (up to April)</i>	<i>138,223.89</i>	<i>33,123.43</i>	<i>4.17</i>
<i>Overall</i>	<i>426,875.85</i>	<i>308,094.05</i>	<i>1.39</i>

CONTINUOUS STERILIZATION SYSTEM EXPENDITURES (ULU SEBOL PALM OIL MILL)

<i>Year</i>	<i>Expenditure (RM)</i>	<i>FFB processed (tonnes)</i>	<i>Cost per tonne (RM/t.FFB)</i>
<i>2008 (Aug to Dec)</i>	<i>7,500.00</i>	<i>83,557.13</i>	<i>0.09</i>
<i>2009</i>	<i>127,000.00</i>	<i>165,494.66</i>	<i>0.77</i>
<i>2010 (up to April)</i>	<i>13,800.00</i>	<i>45,382.55</i>	<i>0.30</i>
<i>Overall</i>	<i>148,300.00</i>	<i>294,434.34</i>	<i>0.50</i>

COMPARISON OF FFA CONTENT

<i>Mill</i>	<i>2008</i>		<i>2010</i>	
	<i>Period</i>	<i>FFA content</i>	<i>Period</i>	<i>FFA content</i>
<i>Sungai Terah</i>	<i>Jan. - May 2008</i>	<i>4.76</i>	<i>Jan. - Apr. 2010</i>	<i>3.67</i>
<i>Kota Bahagia</i>	<i>Jan. - June 2008</i>	<i>5.68</i>	<i>Jan. - Apr. 2010</i>	<i>3.67</i>
<i>Bukit Puteri</i>	<i>Jan. - June 2008</i>	<i>4.91</i>	<i>Jan. - Apr. 2010</i>	<i>3.22</i>
<i>Sachiew</i>	<i>-</i>	<i>-</i>	<i>Jan. - Apr. 2010</i>	<i>3.41</i>
<i>Jak Luay (Indon)</i>	<i>-</i>	<i>-</i>	<i>Jan - Mar. 2010</i>	<i>2.91</i>
<i>PT. KED (Indon)</i>	<i>-</i>	<i>-</i>	<i>Apr. 2010</i>	<i>2.71</i>

PRE-HEATING IMMEDIATELY AFTER CRUSHING



Bunches must be pre-heated immediately after crushing to minimize FFA rise.

SIMPLIFIED MILL OPERATION



The operation and supervision of mills is greatly simplified and can be carried out using a significantly reduced number of operators.

NUMBER OF OPERATORS PER SHIFT

<i>Mill</i>	<i>Rated throughput (t/h)</i>	<i>2008</i>	<i>2010</i>
<i>Ladang Pasir Besar</i>	<i>10</i>	<i>8</i>	<i>9</i>
<i>Sungai Terah</i>	<i>20</i>	<i>11</i>	<i>11</i>
<i>Kota Bahagia</i>	<i>30</i>	<i>20</i>	<i>17</i>
<i>Bukit Puteri</i>	<i>20</i>	<i>10</i>	<i>10</i>
<i>Balingian</i>	<i>45</i>	<i>12/13</i>	<i>12/13</i>
<i>Ulu Sebol</i>	<i>40</i>	<i>-</i>	<i>12</i>
<i>Judan</i>	<i>40</i>	<i>-</i>	<i>12</i>
<i>Sachiew</i>	<i>30</i>	<i>-</i>	<i>9</i>
<i>PT. KED</i>	<i>45</i>	<i>-</i>	<i>14</i>

IMPACT OF CONTINUOUS STERILIZATION PROCESS ON PROCESS LABOUR COST

<i>Average monthly wage (RM)</i>	<i>Process labour cost per annum (RM)</i>		
	<i>Batch sterilization⁺</i>	<i>Continuous sterilization⁺⁺</i>	<i>Cost saving* (RM/t FFB)</i>
<i>750</i>	<i>450,000</i>	<i>180,000</i>	<i>1.88</i>
<i>1000</i>	<i>600,000</i>	<i>240,000</i>	<i>2.50</i>
<i>1250</i>	<i>750,000</i>	<i>300,000</i>	<i>3.13</i>

⁺ *Based on 25 operators per shift*

^{*} *Based on 144,000 tonnes FFB per annum*

⁺⁺ *Based on 10 operators per shift*

TRASH REMOVAL



One-Step Trash Removal



Two-Step Trash Removal

Compared to the conventional milling process, it will be much easier to introduce an additional processing step for removing the trash from FFB as they are being continuously conveyed.

ADVANTAGES OF TRASH REMOVAL



- ❖ The removal of sand will lead to lower operating and maintenance cost.
- ❖ Quality of oil is likely to improve, since the presence of abrasive sand particles can lead to higher iron pick-up.

CONCLUSIONS

- ❖ **The OER of mills using continuous sterilization is comparable or better than conventional mills.**
- ❖ **The stripping efficiency in mills using continuous sterilization is better than in conventional mills, thus reducing the unquantifiable losses in a mill.**
- ❖ **There is a significant reduction in the manpower requirements compared to conventional mills.**
- ❖ **Significant improvements in pressing and clarification plants performance have been observed since the last assessment.**
- ❖ **There has been a significant reduction in the FFA content of the production oil since the last assessment.**
- ❖ **The sterilization time has been increased from about 60 minutes to about 80 to 90 minutes.**