EFFECTS OF CRUDE PALM OIL ON THE PHYSICO-CHEMICAL PROPERTIES OF POLYETHYLENE BLOWN FILM

By

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Dedication

With gratitude for their love, support, and guidance,

I dedicate this thesis to my parents,

U Nay Myo Aung and Daw Ah Mar Sein
The influence of small amounts of crude palm oil (CPO) content on the physical and chemical properties of high density polyethylene (HDPE) and linear low-density polyethylene (LLDPE) have been investigated. HDPE and LLDPE containing, 2, 3 and 5% CPO were prepared in a twin-screw extruder. Then, films of 0.2mm thickness were produced by using blown film technique. The melting point of CPO is 35.65°C and melting point of PE is 130-140°C in HDPE and 85-125°C in LLDPE. Thermal observation by Differential Scanning Calorimetry (DSC) is not significant in melting and crystallisation. Similar observation was also presented in storage modulus, tan δ and loss modulus of Dynamic Mechanical Analysis (DMA) results.

The improvement of tensile strength and elongation at break showed that the enhancement in toughness of the polymers in the addition of CPO. A gradual increase in impact strength of HDPE with the CPO content further supported above
notation. The enhancement in the physical properties in the presence of CPO is believed to be attributed to the increased chain mobility of the polymer along with improved orientation strengthening in HDPE and LLDPE. Evidence from Scanning Electron Micrographs (SEM) were also used to support this contention. However, the decline in impact strength of LLDPE with the addition of CPO is associated with the formation of defects in amorphous phase of LLDPE.

With increasing of CPO addition, viscosity is increased at the low shear rate in rheological examination. Melt Flow Index (MFI) value is increased with the incremental of CPO addition. FT-IR analysis shows that almost same spectra of modified PE with control. The results indicate that no chemical reaction occurred between PE and CPO.
Kajian mengenai pengaruh kandungan minyak sawit mentah (CPO) dalam kuantiti yang kecil terhadap keadaan fizikal dan ciri-ciri kimia politeline ketumpatan tinggi (HDPE) dan politeline ketumpatan rendah (LLDPE) telah dijalankan. HDPE dan LLDPE yang mengandungi 2, 3 dan 5 % CPO disediakan di dalam ‘twin-screw extruder’. Kemudian, filem-filem dengan ketebalan 0.2mm dihasilkan dengan melalui teknik pencairan filem. Takat lebur bagi CPO ialah 35.65°C manakala, bagi PE pula ialah 130-140°C di dalam HDPE dan 85-125°C di dalam LLDPE. Pemerhatian dari segi haba pula tidak signifikan untuk peleburan dan pengkristalan. Pemerhatian yang sama turut ditunjukkan dalam modulus simpanan, tan δ dan modulus pengurangan dalam keputusan analisis mekanikal dinamik (DMA). Peningkatan dalam kekuatan regangan dan pemanjangan pada titik penamat dengan penyelarasan penurunan telah meningkatkan tahap
kekerasan polimer melalui penambahan CPO. Manakala, penurunan secara berperingkat dalam kesan kekuatan HDPE yang mengandungi CPO telah menyokong ‘above notation’. Peningkatan ciri-ciri fizikal dengan kehadiran CPO dipercayai menyumbang kepada peningkatan pergerakan rantaian polimer selaras dengan perkembangan orientasi kekuatan HDPE dan LLDPE. Bukti-bukti daripada pengimbas Mikrograf Elektron juga turut digunakan untuk menyokong pendapat ini. Walau bagaimanapun, penurunan dalam kesan kekuatan LLDPE yang mengandungi CPO adalah sama dengan pembentukan kerosakan dalam fasa amorphous LLDPE.

Indeks Aliran Lebur (MFI) berkurangan dengan peningkatan kandungan CPO. Kelikatan yang berkurangan dengan kadar sekata pula menunjukkan tahap kelinciran CPO. Ini membuktikan bahawa kemampuan pemprosesan PE adalah meningkat dengan penambahan CPO. Sifat-sifat rheologikal juga sepadan dengan perubahan morfologi terhadap politeline yang telah dimodifikasi. Aliran ciri-ciri CPO/ PE pula tidak menunjukkan perubahan sebagaimana yang dijangka dengan mengambil kira CPO sebagai agen penyesuaian. Begitu juga keputusan analisis daripada Fourier Transform Infrared (FTIR) yang menunjukkan secara relatifnya interaksi intermolekular yang kuat antara CPO dan PE adalah wujud dalam filem PE termodifikasi.
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Finally, I dedicate this thesis to my beloved family, in particular, my parents, without their love, support and encouragement, it would not be possible for me.
I certify that an Examination Committee has met on 13 April 2006 to conduct the final examination of Min Min Aung on her Master of Science entitled “Effect of Crude Palm Oil on the physio-chemical properties of polyethylene blown film” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

MIN MIN AUNG

Date:
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LIST OF ABBREVIATIONS/ NOTATIONS

CPO  Crude palm oil
PE   Polyethylene
LDPE Low density polyethylene
LLDPE Linear low density polyethylene
HDPE High density polyethylene
DMA  Dynamic mechanical analysis
DSC  Differential scanning calorimetry
MD   Machine direction
TD   Transverse direction
SEM  Scanning electron microscopy
Ts   Tensile strength
Eb   Elongation at break
MFI  Melt Flow Index
SCB  Short chain branching
UTM  Instron Universal Testing Machine
ECSR Environmental Stress-Crack Resistance
MWD  Molecular weight distribution
HMW  High molecular weight
LCB  Long chain branch
EPOP Epoxidized palm oil and palm oil products
ESBO Epoxidized soyabean oil
<table>
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<tr>
<th>Abbreviation</th>
<th>Full Form</th>
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<tr>
<td>PVC</td>
<td>Polyvinyl chloride</td>
</tr>
<tr>
<td>PP</td>
<td>Polypropylene</td>
</tr>
<tr>
<td>OTR</td>
<td>Oxygen transmission rate</td>
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<tr>
<td>WVTR</td>
<td>Water vapour transmission rate</td>
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<tr>
<td>PS</td>
<td>Polystyrene</td>
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<tr>
<td>MPE</td>
<td>Maleated polyethylene</td>
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<tr>
<td>ASTM</td>
<td>American society of testing and materials</td>
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<tr>
<td>DOBI</td>
<td>Deterioration of bleachability index</td>
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<tr>
<td>VLDPE</td>
<td>Very low density polyethylene</td>
</tr>
<tr>
<td>EVA</td>
<td>Ethylene vinyl acetate</td>
</tr>
<tr>
<td>FFB</td>
<td>Fresh fruit bunches</td>
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<tr>
<td>DOBI</td>
<td>Deterioration of bleach ability index</td>
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<tr>
<td>LVDT</td>
<td>High sensitivity displacement detector</td>
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<tr>
<td>DBS</td>
<td>Distance between the supports</td>
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<tr>
<td>FTIR</td>
<td>Fourier transform infrared spectra</td>
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<tr>
<td>WS</td>
<td>Water sorption</td>
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<tr>
<td>Symbol</td>
<td>Description</td>
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<td>--------</td>
<td>-------------------------------------------------------</td>
</tr>
<tr>
<td>$T_c$</td>
<td>Crystallisation temperature</td>
</tr>
<tr>
<td>$T_m$</td>
<td>Melting point</td>
</tr>
<tr>
<td>$\omega_c$</td>
<td>Thermal conductivity</td>
</tr>
<tr>
<td>$\rho_a$</td>
<td>Density of amorphous phase</td>
</tr>
<tr>
<td>$\rho_c$</td>
<td>Density of crystalline phase</td>
</tr>
<tr>
<td>$\rho$</td>
<td>Density of polymer</td>
</tr>
<tr>
<td>$E'$</td>
<td>Storage modulus</td>
</tr>
<tr>
<td>$E''$</td>
<td>Loss modulus</td>
</tr>
<tr>
<td>$T_g$</td>
<td>Glass transition temperature</td>
</tr>
<tr>
<td>M50</td>
<td>The dart drop impact weight</td>
</tr>
<tr>
<td>Mo</td>
<td>The lowest missile weight</td>
</tr>
<tr>
<td>Dw</td>
<td>Uniform weight decrement/ increment</td>
</tr>
<tr>
<td>A/N</td>
<td>Sum of number of failure occurred at a specified mass multiply by the number of mass increment and sum of failed specimen respectively</td>
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