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APPENDIX G: Calculation of Acid Number of High Molecular Weight Styrene Acrylic Copolymers and Blended Resins

**Standardization of Potassium hydroxide (KOH)**

\[ N = \frac{1000 \times W_{\text{KHP}}}{204.23 \times V_{\text{eq}}} \]

Where,  
\[ N = \text{Normality of standardized KOH solution} \]
\[ W_{\text{KHP}} = \text{Weight of Potassium hydrogen phthalate (KHP) used, g} \]
\[ V_{\text{eq}} = \text{Volume of KOH used for the sample titration, ml} \]

204.23 = equivalent weight of KHP

<table>
<thead>
<tr>
<th>Test 1</th>
<th>Test 2</th>
<th>Test 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight of KHP/ g</td>
<td>0.5068</td>
<td>0.5056</td>
</tr>
<tr>
<td>Initial reading of KOH, ( V_0 )/ ml</td>
<td>1.10</td>
<td>0.50</td>
</tr>
<tr>
<td>Final reading of KOH, ( V_1 )/ ml</td>
<td>32.90</td>
<td>32.50</td>
</tr>
<tr>
<td>Total of KOH used, ( V_{\text{eq}} )/ ml</td>
<td>31.80</td>
<td>32.00</td>
</tr>
<tr>
<td>Normality, ( N )</td>
<td>0.0780</td>
<td>0.0774</td>
</tr>
</tbody>
</table>

Average Normality, \( N = \frac{N_{\text{Test 1}} + N_{\text{Test 2}} + N_{\text{Test 3}}}{3} \)

\[ = 0.0777N \]

**Blank Titration of Toluene**

<table>
<thead>
<tr>
<th>Test 1</th>
<th>Test 2</th>
<th>Test 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial reading of KOH, ( V_0 )/ ml</td>
<td>1.00</td>
<td>1.05</td>
</tr>
<tr>
<td>Final reading of KOH, ( V_1 )/ ml</td>
<td>1.05</td>
<td>2.00</td>
</tr>
<tr>
<td>Total of KOH used, ( V_{\text{blank}} )/ ml</td>
<td>0.05</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Average \( V_{\text{blank}} = \frac{(V_{\text{blank}} \text{ (Test 1)} + V_{\text{blank}} \text{ (Test 2)} + V_{\text{blank}} \text{ (Test 3)})}{3} \)

\[ = 0.05 \text{ml} \]
Table G.1: Calculation of Acid Number of High Molecular Weight Styrene Acrylic Copolymers

<table>
<thead>
<tr>
<th>Sample Code</th>
<th>H22-TR</th>
<th>H15-TR</th>
<th>H16-TR</th>
<th>H17-TR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Test 1</td>
<td>Test 2</td>
<td>Test 3</td>
<td>Test 1</td>
</tr>
<tr>
<td>Weight of sample/ g</td>
<td>1.0181</td>
<td>1.0405</td>
<td>1.058</td>
<td>1.0103</td>
</tr>
<tr>
<td>Initial reading of KOH, V0 / ml</td>
<td>1.10</td>
<td>2.20</td>
<td>3.40</td>
<td>4.60</td>
</tr>
<tr>
<td>Final reading of KOH, V1 / ml</td>
<td>2.20</td>
<td>3.40</td>
<td>4.60</td>
<td>5.75</td>
</tr>
<tr>
<td>Total of KOH used, Veq / ml</td>
<td>1.10</td>
<td>1.20</td>
<td>1.20</td>
<td>1.15</td>
</tr>
<tr>
<td>Acid Number / mgKOHg-1</td>
<td>4.50</td>
<td>4.82</td>
<td>4.74</td>
<td>4.75</td>
</tr>
<tr>
<td>Average</td>
<td>4.68</td>
<td>4.92</td>
<td>4.42</td>
<td>3.64</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sample Code</th>
<th>H23-TR</th>
<th>H18-TR</th>
<th>H19-TR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Test 1</td>
<td>Test 2</td>
<td>Test 3</td>
</tr>
<tr>
<td>Weight of sample/ g</td>
<td>1.0372</td>
<td>1.0113</td>
<td>1.0256</td>
</tr>
<tr>
<td>Initial reading of KOH, V0 / ml</td>
<td>3.45</td>
<td>3.60</td>
<td>4.50</td>
</tr>
<tr>
<td>Final reading of KOH, V1 / ml</td>
<td>4.20</td>
<td>4.50</td>
<td>5.30</td>
</tr>
<tr>
<td>Total of KOH used, Veq / ml</td>
<td>0.75</td>
<td>0.90</td>
<td>0.80</td>
</tr>
<tr>
<td>Acid Number / mgKOHg-1</td>
<td>2.94</td>
<td>3.66</td>
<td>3.19</td>
</tr>
<tr>
<td>Average</td>
<td>3.26</td>
<td>4.04</td>
<td>2.34</td>
</tr>
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</table>
Table G.2: Calculation of Acid Number of Blended Resins

<table>
<thead>
<tr>
<th>Sample Code</th>
<th>M08-TR</th>
<th>M09-TR</th>
<th>M10-TR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Test 1</td>
<td>Test 2</td>
<td>Test 3</td>
</tr>
<tr>
<td>Weight of sample/ g</td>
<td>1.0451</td>
<td>1.0413</td>
<td>1.0495</td>
</tr>
<tr>
<td>Initial reading of KOH, V0 / ml</td>
<td>4.20</td>
<td>5.00</td>
<td>5.70</td>
</tr>
<tr>
<td>Final reading of KOH, V1 / ml</td>
<td>4.85</td>
<td>5.70</td>
<td>6.35</td>
</tr>
<tr>
<td>Total of KOH used, Veq / ml</td>
<td>0.65</td>
<td>0.70</td>
<td>0.65</td>
</tr>
<tr>
<td>Acid Number / mgKOHg-1</td>
<td>2.50</td>
<td>2.72</td>
<td>2.49</td>
</tr>
<tr>
<td>Average</td>
<td>2.57</td>
<td>2.82</td>
<td>2.99</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sample Code</th>
<th>M11-TR</th>
<th>M12-TR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Test 1</td>
<td>Test 2</td>
</tr>
<tr>
<td>Weight of sample/ g</td>
<td>1.039</td>
<td>1.1827</td>
</tr>
<tr>
<td>Initial reading of KOH, V0 / ml</td>
<td>6.30</td>
<td>7.50</td>
</tr>
<tr>
<td>Final reading of KOH, V1 / ml</td>
<td>7.10</td>
<td>8.40</td>
</tr>
<tr>
<td>Total of KOH used, Veq / ml</td>
<td>0.80</td>
<td>0.90</td>
</tr>
<tr>
<td>Acid Number / mgKOHg-1</td>
<td>3.15</td>
<td>3.13</td>
</tr>
<tr>
<td>Average</td>
<td>3.16</td>
<td>3.23</td>
</tr>
</tbody>
</table>
APPENDIX H: Calculation of Percentage of THF Insoluble Fraction of High Molecular Weight Styrene Acrylic Copolymers and Blended Resins

Table H.1: Calculation of Percentage of THF Insoluble Fraction of High Molecular Weight Styrene Acrylic Copolymers

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight of sample, w/ g</td>
<td>1.0413</td>
<td>1.0324</td>
<td>1.1827</td>
<td>1.0137</td>
<td>1.1495</td>
<td>1.0261</td>
<td>1.0644</td>
</tr>
<tr>
<td>Weight of filter paper, w0/ g</td>
<td>0.7935</td>
<td>0.7965</td>
<td>0.8032</td>
<td>0.7806</td>
<td>0.7824</td>
<td>0.7948</td>
<td>0.7985</td>
</tr>
<tr>
<td>Weight of (filter paper + residue), w1/ g</td>
<td>0.8989</td>
<td>0.9244</td>
<td>1.0245</td>
<td>0.9170</td>
<td>0.8888</td>
<td>0.9677</td>
<td>1.5215</td>
</tr>
<tr>
<td>w1-w0 /g</td>
<td>0.1054</td>
<td>0.1279</td>
<td>0.2213</td>
<td>0.1364</td>
<td>0.1064</td>
<td>0.1729</td>
<td>0.7230</td>
</tr>
</tbody>
</table>

Table H.2: Calculation of Percentage of THF Insoluble Fraction of Blended Resins

<table>
<thead>
<tr>
<th>Sample Code</th>
<th>M08-TR</th>
<th>M09-TR</th>
<th>M10-TR</th>
<th>M11-TR</th>
<th>M12-TR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight of sample, w/ g</td>
<td>1.0402</td>
<td>1.0145</td>
<td>1.0338</td>
<td>1.0048</td>
<td>1.0108</td>
</tr>
<tr>
<td>Weight of filter paper, w0/ g</td>
<td>0.7986</td>
<td>0.7910</td>
<td>0.7909</td>
<td>0.7909</td>
<td>0.7971</td>
</tr>
<tr>
<td>Weight of (filter paper + residue), w1/ g</td>
<td>0.8918</td>
<td>0.8862</td>
<td>0.8879</td>
<td>0.9294</td>
<td>0.9324</td>
</tr>
<tr>
<td>w1-w0 /g</td>
<td>0.0932</td>
<td>0.0952</td>
<td>0.0970</td>
<td>0.1385</td>
<td>0.1353</td>
</tr>
<tr>
<td>% THF Insoluble Fraction</td>
<td>8.96</td>
<td>9.38</td>
<td>9.38</td>
<td>13.78</td>
<td>13.39</td>
</tr>
</tbody>
</table>
APPENDIX I: Estimation of $T_g$ by using Fox equation and Gordon-Taylor equation

(a) Fox equation:

$$\frac{1}{T_g} = \frac{w_1}{T_{g1}} + \frac{w_2}{T_{g2}}$$

Where $T_{g1} = T_g$’s of the poly(butyl acrylate), 218 K

$T_{g2} = T_g$’s of the polystyrene, 373 K

$w_1$ = respective weight fractions of poly(butyl acrylate) in the mixture

$w_2$ = respective weight fractions of polystyrene in the mixture.

Example:

Sample L20-TR, $w_1 = 0.25$ and $w_2 = 0.75$

$$\frac{1}{T_g} = \frac{0.25}{218} + \frac{0.75}{373}$$

$$\frac{1}{T_g} = \frac{0.25}{218} + \frac{0.75}{373}$$

Where $T_{g1} = 218$ K and $T_{g2} = 373$ K

So, $T_g = 316.70$ K

Likewise, $T_g$ of other samples were calculated.

Table 1.1: Estimation of $T_g$ of Low Molecular Weight Styrene Acrylic Copolymers by using Fox equation

<table>
<thead>
<tr>
<th>Sample</th>
<th>L20-TR</th>
<th>L21-TR</th>
<th>L22-TR</th>
<th>L15-TR</th>
<th>L-16TR</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_g$/K</td>
<td>316.70</td>
<td>326.56</td>
<td>337.05</td>
<td>348.24</td>
<td>360.19</td>
</tr>
</tbody>
</table>
Table I.2: Estimation of $T_g$ of High Molecular Weight Styrene Acrylic Copolymers by using Fox equation

<table>
<thead>
<tr>
<th>Sample</th>
<th>H22-TR</th>
<th>H15-TR</th>
<th>H16-TR</th>
<th>H17-TR</th>
<th>H23-TR</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_g$/K</td>
<td>316.35</td>
<td>326.18</td>
<td>336.65</td>
<td>347.81</td>
<td>359.73</td>
</tr>
</tbody>
</table>

(b) Gordon-Taylor equation:

$$T_g = \frac{(w_1T_{g1} + kw_2T_{g2})}{(w_1 + kw_2)}$$

Where $T_{g1} = T_g$'s of the poly(butyl acrylate), 218 K

$T_{g2} = T_g$'s of the polystyrene, 373 K

$w_1 = $ respective weight fractions of poly(butyl acrylate) in the mixture

$w_2 = $ respective weight fractions of polystyrene in the mixture.

$k = $ fitting factor

**Calculation of $k$**

**Example:**

Sample L20-TR, $w_1 = 0.25$ and $w_2 = 0.75$

$$T_g = \frac{(w_1T_{g1} + kw_2T_{g2})}{(w_1 + kw_2)}$$

$$T_g = \frac{(0.25T_{g1} + 0.75T_{g2})}{(0.25 + 0.75)}$$

Where $T_{g1} = 218$ K, $T_{g2} = 373$ K and $T_g = T_g\text{exp} = 312$ K

So, $k = 0.5137$

Likewise, $k$ of other samples was calculated.
Table I.3: Calculation of fitting factor, $k$ of Low Molecular Weight Styrene Acrylic Copolymers by using Gordon-Taylor equation

<table>
<thead>
<tr>
<th>Sample</th>
<th>L20-TR</th>
<th>L21-TR</th>
<th>L22-TR</th>
<th>L15-TR</th>
<th>L-16TR</th>
</tr>
</thead>
<tbody>
<tr>
<td>$k$</td>
<td>0.5137</td>
<td>0.4298</td>
<td>0.3396</td>
<td>0.2716</td>
<td>0.1679</td>
</tr>
</tbody>
</table>

Average $k = 0.3445$

Table I.4: Calculation of fitting factor, $k$ of High Molecular Weight Styrene Acrylic Copolymers by using Gordon-Taylor equation

<table>
<thead>
<tr>
<th>Sample</th>
<th>H22-TR</th>
<th>H15-TR</th>
<th>H16-TR</th>
<th>H17-TR</th>
<th>H23-TR</th>
</tr>
</thead>
<tbody>
<tr>
<td>$k$</td>
<td>0.7273</td>
<td>0.7273</td>
<td>0.5860</td>
<td>0.5056</td>
<td>0.3556</td>
</tr>
</tbody>
</table>

Average $k = 0.5804$

Calculation of $T_g$

(i) Low Molecular Weight Styrene Acrylic Copolymers

$T_g$ of other samples was calculated by fitting $k = 0.3445$ into the Gordon-Taylor equation.

Example:

Sample L20-TR, $w_1 = 0.25$ and $w_2 = 0.75$

$$T_g = \frac{0.25T_{g1} + 0.75T_{g2}}{0.25 + 0.75}$$

Where $T_{g1} = 218$ K, $T_{g2} = 373$ K, and $k = 0.3445$,

So, $T_g = 296.78$ K

Likewise, $T_g$ of other samples were calculated.
Table I.5: Estimation of $T_g$ of Low Molecular Weight Styrene Acrylic Copolymers by using Gordon-Taylor equation

<table>
<thead>
<tr>
<th>Sample</th>
<th>L20-TR</th>
<th>L21-TR</th>
<th>L22-TR</th>
<th>L15-TR</th>
<th>L-16TR</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_g$/K</td>
<td>296.78</td>
<td>307.82</td>
<td>320.68</td>
<td>335.20</td>
<td>352.46</td>
</tr>
</tbody>
</table>

(ii) High Molecular Weight Styrene Acrylic Copolymers

$T_g$ of other samples was calculated by fitting $k = 0.5804$ into the Gordon-Taylor equation.

Example:

Sample H20-TR, $w_1 = 0.28$ and $w_2 = 0.70$

$$T_g = \frac{(0.28T_{g1} + k0.70T_{g2})}{(0.28 + k0.70)}$$

Where $T_{g1} = 218$ K, $T_{g2} = 373$ K, and $k = 0.5804$,

So, $T_g = 309.76$ K

Likewise, $T_g$ of other samples were calculated.

Table I.6: Estimation of $T_g$ of High Molecular Weight Styrene Acrylic Copolymers by using Gordon-Taylor equation

<table>
<thead>
<tr>
<th>Sample</th>
<th>H22-TR</th>
<th>H15-TR</th>
<th>H16-TR</th>
<th>H17-TR</th>
<th>H23-TR</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_g$/K</td>
<td>309.76</td>
<td>319.42</td>
<td>329.70</td>
<td>340.67</td>
<td>352.41</td>
</tr>
</tbody>
</table>
APPENDIX J

Test Print Images of M09-FT
APPENDIX K

Test Print Images of M10-FT
APPENDIX L

Test Print Images of M11-FT
APPENDIX M

Test Print Images of commercial toner A