Supplementary Information

**Thiacloprid suspension formula optimization by a response surface methodology**

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**Figure S1.** Measured values vs. predicted values for modeled centrifugal sedimentation ratio.

**Figure S2.** Measured values vs. predicted values for modeled viscosity.
### Table S1. Proposed experiments by RSM and their corresponding output parameters.

<table>
<thead>
<tr>
<th>No.</th>
<th>Tersperse</th>
<th>AE1601</th>
<th>Xanthan gum</th>
<th>Veegum</th>
<th>Aqueous separation ratio/%</th>
<th>Centrifugal sedimentation ratio/%</th>
<th>Viscosity/mPa·s</th>
<th>Dispersibility</th>
<th>Susceptibility/%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-1</td>
<td>-1</td>
<td>-1</td>
<td>-1</td>
<td>16.83 ± 0.12 a</td>
<td>22.45 ± 0.37 a</td>
<td>176.60 ± 1.16 t</td>
<td>Excellent</td>
<td>94.78 ± 0.53</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>-1</td>
<td>-1</td>
<td>-1</td>
<td>15.11 ± 0.14 b</td>
<td>19.93 ± 0.25 b</td>
<td>160.34 ± 0.10 u</td>
<td>Excellent</td>
<td>96.05 ± 0.23</td>
</tr>
<tr>
<td>3</td>
<td>-1</td>
<td>1</td>
<td>-1</td>
<td>-1</td>
<td>10.47 ± 0.12 d</td>
<td>16.58 ± 0.09 e</td>
<td>189.62 ± 0.08 r</td>
<td>Excellent</td>
<td>95.70 ± 0.89</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>1</td>
<td>-1</td>
<td>1</td>
<td>8.82 ± 0.14 e</td>
<td>14.43 ± 0.39 g</td>
<td>209.22 ± 0.20 p</td>
<td>Excellent</td>
<td>96.34 ± 0.53</td>
</tr>
<tr>
<td>5</td>
<td>-1</td>
<td>-1</td>
<td>1</td>
<td>-1</td>
<td>7.67 ± 0.07 f</td>
<td>16.45 ± 0.11 e</td>
<td>241.76 ± 0.39 k</td>
<td>Fine</td>
<td>95.45 ± 0.19</td>
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<tr>
<td>6</td>
<td>1</td>
<td>-1</td>
<td>1</td>
<td>1</td>
<td>4.70 ± 0.07 h</td>
<td>11.14 ± 0.33 jk</td>
<td>240.16 ± 0.19 i</td>
<td>Excellent</td>
<td>95.97 ± 0.42</td>
</tr>
<tr>
<td>7</td>
<td>-1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>6.35 ± 0.11 g</td>
<td>11.99 ± 0.09 hi</td>
<td>243.64 ± 0.81 k</td>
<td>Fine</td>
<td>93.68 ± 0.42</td>
</tr>
<tr>
<td>8</td>
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<td>1</td>
<td>-1</td>
<td>1</td>
<td>4.67 ± 0.10 h</td>
<td>7.28 ± 0.19 o</td>
<td>281.92 ± 0.11 f</td>
<td>Fine</td>
<td>95.17 ± 0.45</td>
</tr>
<tr>
<td>9</td>
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<td>-1</td>
<td>-1</td>
<td>1</td>
<td>9.98 ± 0.05 d</td>
<td>18.60 ± 0.07 c</td>
<td>212.90 ± 0.13 o</td>
<td>Fine</td>
<td>93.30 ± 0.48</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
<td>-1</td>
<td>-1</td>
<td>1</td>
<td>6.60 ± 0.08 g</td>
<td>15.64 ± 0.32 f</td>
<td>174.02 ± 0.60 t</td>
<td>Excellent</td>
<td>95.22 ± 0.85</td>
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<tr>
<td>11</td>
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<td>1</td>
<td>-1</td>
<td>1</td>
<td>4.55 ± 0.12 h</td>
<td>12.46 ± 0.31 h</td>
<td>252.14 ± 0.14 j</td>
<td>Fine</td>
<td>96.06 ± 0.25</td>
</tr>
<tr>
<td>12</td>
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<td>1</td>
<td>-1</td>
<td>-1</td>
<td>1.50 ± 0.11 i</td>
<td>10.04 ± 0.51 i</td>
<td>260.92 ± 0.59 h</td>
<td>Excellent</td>
<td>95.49 ± 0.61</td>
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<tr>
<td>13</td>
<td>-1</td>
<td>-1</td>
<td>1</td>
<td>1</td>
<td>4.88 ± 0.12 hi</td>
<td>10.57 ± 0.24 kl</td>
<td>268.86 ± 0.28 g</td>
<td>Fine</td>
<td>93.19 ± 0.27</td>
</tr>
<tr>
<td>14</td>
<td>1</td>
<td>-1</td>
<td>1</td>
<td>1</td>
<td>1.81 ± 0.10 n</td>
<td>5.70 ± 0.28 p</td>
<td>283.66 ± 0.83 ef</td>
<td>Fine</td>
<td>94.10 ± 0.37</td>
</tr>
<tr>
<td>15</td>
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<td>1</td>
<td>1</td>
<td>3.92 ± 0.10 ij</td>
<td>6.91 ± 0.19 o</td>
<td>330.22 ± 0.87 c</td>
<td>Fine</td>
<td>95.43 ± 0.46</td>
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<td>1</td>
<td>1</td>
<td>1.22 ± 0.03 o</td>
<td>2.31 ± 0.15 q</td>
<td>345.78 ± 0.08 a</td>
<td>Fine</td>
<td>94.80 ± 0.32</td>
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<tr>
<td>17</td>
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<td>0</td>
<td>0</td>
<td>6.90 ± 0.10 g</td>
<td>15.36 ± 0.21 f</td>
<td>219.58 ± 0.62 n</td>
<td>Fine</td>
<td>93.29 ± 0.53</td>
</tr>
<tr>
<td>18</td>
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<td>0</td>
<td>0</td>
<td>2.74 ± 0.07 m</td>
<td>8.17 ± 0.24 n</td>
<td>225.38 ± 0.08 m</td>
<td>Excellent</td>
<td>96.05 ± 0.40</td>
</tr>
<tr>
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<td>0</td>
<td>0</td>
<td>8.91 ± 0.06 e</td>
<td>17.34 ± 0.35 d</td>
<td>208.64 ± 0.14 p</td>
<td>Excellent</td>
<td>93.12 ± 0.75</td>
</tr>
<tr>
<td>20</td>
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<td>0</td>
<td>3.04 ± 0.13 lm</td>
<td>7.36 ± 0.14 o</td>
<td>286.08 ± 0.11 e</td>
<td>Excellent</td>
<td>94.94 ± 0.25</td>
</tr>
<tr>
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<td>0</td>
<td>11.42 ± 0.17 c</td>
<td>20.47 ± 0.25 b</td>
<td>185.76 ± 0.10 s</td>
<td>Excellent</td>
<td>94.77 ± 0.35</td>
</tr>
<tr>
<td>22</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>1.77 ± 0.08 no</td>
<td>5.60 ± 0.26 p</td>
<td>336.46 ± 1.01 b</td>
<td>Fine</td>
<td>93.55 ± 0.42</td>
</tr>
<tr>
<td>23</td>
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<td>0</td>
<td>0</td>
<td>-2</td>
<td>14.83 ± 0.13 b</td>
<td>19.02 ± 0.19 c</td>
<td>197.68 ± 0.08 q</td>
<td>Excellent</td>
<td>92.84 ± 0.16</td>
</tr>
<tr>
<td>24</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>3.64 ± 0.08 tk</td>
<td>9.30 ± 0.29 m</td>
<td>296.94 ± 0.48 d</td>
<td>Fine</td>
<td>97.02 ± 0.21</td>
</tr>
<tr>
<td>25</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>3.50 ± 0.08 jk</td>
<td>11.64 ± 0.16 ij</td>
<td>255.10 ± 0.49 i</td>
<td>Fine</td>
<td>94.21 ± 0.41</td>
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<td>26</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3.40 ± 0.08 jk</td>
<td>11.80 ± 0.17 hij</td>
<td>256.66 ± 0.48 i</td>
<td>Fine</td>
<td>94.96 ± 0.20</td>
</tr>
<tr>
<td>27</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3.14 ± 0.09 km</td>
<td>11.43 ± 0.11 ij</td>
<td>250.88 ± 0.08 j</td>
<td>Fine</td>
<td>94.52 ± 0.34</td>
</tr>
</tbody>
</table>

*The levels of adjuvants were coded value. Each data of dependent variable is the mean ± SE. Data of the same index with different lowercase letters are significantly different at p < 0.05 level by Tukey test.
**Table S2.** The ANOVA for the aqueous separation ratio

<table>
<thead>
<tr>
<th>Source</th>
<th>Coefficient</th>
<th>F-value</th>
<th>Sequential p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>-</td>
<td>248.39</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Lack of Fit</td>
<td>-</td>
<td>4.51</td>
<td>0.1951</td>
</tr>
<tr>
<td>Intercept</td>
<td>3.35</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>$X_1$</td>
<td>-1.17</td>
<td>231.62</td>
<td>&lt; 0.0001*</td>
</tr>
<tr>
<td>$X_2$</td>
<td>-1.56</td>
<td>409.53</td>
<td>&lt; 0.0001*</td>
</tr>
<tr>
<td>$X_3$</td>
<td>-2.43</td>
<td>995.17</td>
<td>&lt; 0.0001*</td>
</tr>
<tr>
<td>$X_4$</td>
<td>-2.62</td>
<td>1158.72</td>
<td>&lt; 0.0001*</td>
</tr>
<tr>
<td>$X_1X_2$</td>
<td>0.10</td>
<td>1.20</td>
<td>0.2941</td>
</tr>
<tr>
<td>$X_1X_3$</td>
<td>-0.01</td>
<td>0.02</td>
<td>0.9037</td>
</tr>
<tr>
<td>$X_1X_4$</td>
<td>-0.24</td>
<td>6.21</td>
<td>0.0284*</td>
</tr>
<tr>
<td>$X_2X_3$</td>
<td>1.29</td>
<td>187.43</td>
<td>&lt; 0.0001*</td>
</tr>
<tr>
<td>$X_2X_4$</td>
<td>0.14</td>
<td>2.36</td>
<td>0.1503</td>
</tr>
<tr>
<td>$X_3X_4$</td>
<td>1.04</td>
<td>121.54</td>
<td>&lt; 0.0001*</td>
</tr>
<tr>
<td>$X_1^2$</td>
<td>0.39</td>
<td>22.89</td>
<td>0.0004*</td>
</tr>
<tr>
<td>$X_2^2$</td>
<td>0.68</td>
<td>69.05</td>
<td>&lt; 0.0001*</td>
</tr>
<tr>
<td>$X_3^2$</td>
<td>0.83</td>
<td>104.28</td>
<td>&lt; 0.0001*</td>
</tr>
<tr>
<td>$X_4^2$</td>
<td>1.49</td>
<td>334.59</td>
<td>&lt; 0.0001*</td>
</tr>
</tbody>
</table>

Note: * indicates significant impact.

**Table S3.** Fitness of centrifugal sedimentation ratio to different models.

<table>
<thead>
<tr>
<th>Model</th>
<th>Sequential p-value</th>
<th>Lack of fit p-value</th>
<th>Adjusted R$^2$</th>
<th>Predicted R$^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear</td>
<td>&lt; 0.0001</td>
<td>0.0320</td>
<td>0.9645</td>
<td>0.9546</td>
</tr>
<tr>
<td>2FI</td>
<td>0.0429</td>
<td>0.0462</td>
<td>0.9765</td>
<td>0.9770</td>
</tr>
<tr>
<td>Quadratic polynomial</td>
<td>&lt; 0.0001</td>
<td>0.4323</td>
<td>0.9980</td>
<td>0.9951</td>
</tr>
<tr>
<td>Cubic polynomial</td>
<td>0.6310</td>
<td>0.2804</td>
<td>0.9977</td>
<td>0.9638</td>
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</tbody>
</table>
### Table S4. The ANOVA for the centrifugal sedimentation ratio

<table>
<thead>
<tr>
<th>Source</th>
<th>Coefficient</th>
<th>$F$-value</th>
<th>Sequential $p$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>-</td>
<td>940.72</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Lack of Fit</td>
<td>-</td>
<td>1.67</td>
<td>0.4323</td>
</tr>
<tr>
<td>Intercept</td>
<td>11.62</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>$X_1$</td>
<td>-1.83</td>
<td>1511.99</td>
<td>&lt; 0.0001*</td>
</tr>
<tr>
<td>$X_2$</td>
<td>-2.43</td>
<td>2677.50</td>
<td>&lt; 0.0001*</td>
</tr>
<tr>
<td>$X_3$</td>
<td>-3.65</td>
<td>6005.32</td>
<td>&lt; 0.0001*</td>
</tr>
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<td>$X_4$</td>
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<td>2590.99</td>
<td>&lt; 0.0001*</td>
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<td>$X_1X_2$</td>
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<td>3.76</td>
<td>0.0763</td>
</tr>
<tr>
<td>$X_1X_3$</td>
<td>-0.59</td>
<td>104.50</td>
<td>&lt; 0.0001*</td>
</tr>
<tr>
<td>$X_1X_4$</td>
<td>-0.01</td>
<td>0.04</td>
<td>0.8540</td>
</tr>
<tr>
<td>$X_2X_3$</td>
<td>0.48</td>
<td>70.14</td>
<td>&lt; 0.0001*</td>
</tr>
<tr>
<td>$X_2X_4$</td>
<td>0.06</td>
<td>0.94</td>
<td>0.3526</td>
</tr>
<tr>
<td>$X_3X_4$</td>
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<td>26.02</td>
<td>0.0003*</td>
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<td>0.01</td>
<td>0.01</td>
<td>0.9066</td>
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<td>$X_2^2$</td>
<td>0.15</td>
<td>9.34</td>
<td>0.0100*</td>
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<td>0.32</td>
<td>42.11</td>
<td>&lt; 0.0001*</td>
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<td>$X_4^2$</td>
<td>0.60</td>
<td>146.85</td>
<td>&lt; 0.0001*</td>
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</tbody>
</table>

Note: * indicates significant impact.

### Table S5. Fitness of the viscosity to different models.

<table>
<thead>
<tr>
<th>Model</th>
<th>Sequential $p$-value</th>
<th>Lack of fit $p$-value</th>
<th>Adjusted $R^2$</th>
<th>Predicted $R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear</td>
<td>&lt; 0.0001</td>
<td>0.0319</td>
<td>0.8988</td>
<td>0.8675</td>
</tr>
<tr>
<td>2FI</td>
<td>0.0208</td>
<td>0.0513</td>
<td>0.9399</td>
<td>0.9144</td>
</tr>
<tr>
<td>Quadratic polynomial</td>
<td>0.0004</td>
<td>0.1696</td>
<td>0.9836</td>
<td>0.9572</td>
</tr>
<tr>
<td>Cubic polynomial</td>
<td>0.7274</td>
<td>0.0831</td>
<td>0.9783</td>
<td>0.5590</td>
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### Table S6. The ANOVA for the viscosity

<table>
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<th>Source</th>
<th>Coefficient</th>
<th>F-value</th>
<th>Sequential p-value</th>
</tr>
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<tbody>
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<td>Lack of Fit</td>
<td>-</td>
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</tr>
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<td>Intercept</td>
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<td>-</td>
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<td>265.43</td>
<td>&lt; 0.0001*</td>
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<td>37.57</td>
<td>829.37</td>
<td>&lt; 0.0001*</td>
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<td>347.70</td>
<td>&lt; 0.0001*</td>
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<td>$X_1X_2$</td>
<td>7.76</td>
<td>23.58</td>
<td>0.0004*</td>
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<tr>
<td>$X_1X_3$</td>
<td>5.86</td>
<td>13.47</td>
<td>0.0032*</td>
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<td>0.4287</td>
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<tr>
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<td>31.78</td>
<td>0.0001*</td>
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<td>$X_3X_4$</td>
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<td>4.94</td>
<td>0.0462*</td>
</tr>
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<td>36.53</td>
<td>&lt; 0.0001*</td>
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<td>2.40</td>
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</tr>
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<td>$X_4^2$</td>
<td>-2.16</td>
<td>2.43</td>
<td>0.1452</td>
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</tbody>
</table>

Note: * indicates significant impact.

### Table S7. Constraints for the multiple-response optimization.

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<th>Name</th>
<th>Goal</th>
<th>Lower limit</th>
<th>Upper limit</th>
<th>Lower weight</th>
<th>Upper weight</th>
<th>Importance</th>
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<td>2.00</td>
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<td>1</td>
<td>3</td>
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<td>Range</td>
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<td>2.00</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>$X_3$: Xanthan gum</td>
<td>Range</td>
<td>-2.00</td>
<td>2.00</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>$X_4$: Veegum</td>
<td>Range</td>
<td>-2.00</td>
<td>2.00</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Aqueous separation ratio/%</td>
<td>Minimize</td>
<td>1.22</td>
<td>5.00</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Centrifugal sedimentation ratio/%</td>
<td>Minimize</td>
<td>2.31</td>
<td>5.00</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Viscosity/ mPa·s</td>
<td>Minimize</td>
<td>160.34</td>
<td>345.78</td>
<td>1</td>
<td>1</td>
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