BOEHMITE AS SYNERGIST FOR FLAME RETARDANT POLYOLEFIN COMPOUNDS

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Boehmite is used as flame retardant additive in combination with other FR products (hydroxides, phosphorus additives, etc.) due to the high temperature application, the smoke suppressant and char promoting effect. ALUPREM® TB 1/T and TB DRY are two grades of boehmite characterized by 99.4% of Al₂O₃ content and with the characteristics reported in the following table.

The performance of the two boehmites have been evaluated in EVA and PE based compounds as partial substitution of magnesium hydroxide (MDH) at increasing levels. All the recipes have been produced at twin-roll mixer at temperature of 140-150°C. Boehmite TB 1/T is indicated with A and TB DRY with B formulations containing only magnesium hydroxide are called 0.

EVA based formulations:
Composition: 70 phr EVA28, 20 phr mLLDPE, 10 phr LLDP-g-MAH, 2 phr silicon lubricant, 1phr stabilizer/antioxidant, 1.5 phr of total fillers (amounts of added boehmite is indicated in the formulation names and they correspond to 12,5, 25 and 37,5 phr).

Table 1. Cone calorimeter test: Boehmite with the finest dispersion and at lower amounts.

<table>
<thead>
<tr>
<th>Properties</th>
<th>EVA-0</th>
<th>EVA-A12.5</th>
<th>EVA-A25</th>
<th>EVA-A37.5</th>
<th>EVA-B12.5</th>
<th>EVA-B25</th>
<th>EVA-B37.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density at 23°C</td>
<td>1,462</td>
<td>1,472</td>
<td>1,480</td>
<td>1,491</td>
<td>1,466</td>
<td>1,383</td>
<td>1,450</td>
</tr>
<tr>
<td>MFI 190°C/21.6 kg</td>
<td>1,1</td>
<td>2,7</td>
<td>3,6</td>
<td>3,1</td>
<td>1,4</td>
<td>4,4</td>
<td>5,2</td>
</tr>
<tr>
<td>Mooney viscosity</td>
<td>51,3</td>
<td>49,2</td>
<td>46,4</td>
<td>45,4</td>
<td>52,9</td>
<td>47,9</td>
<td>46,2</td>
</tr>
<tr>
<td>White index</td>
<td>80,8</td>
<td>81,7</td>
<td>80,4</td>
<td>80,7</td>
<td>79,9</td>
<td>79,8</td>
<td>78,9</td>
</tr>
<tr>
<td>Tensile strength at break (N/m²)</td>
<td>12,5</td>
<td>12,5</td>
<td>11,6</td>
<td>11,6</td>
<td>11,1</td>
<td>11,3</td>
<td>11,1</td>
</tr>
<tr>
<td>Elongation at break (%)</td>
<td>173</td>
<td>182</td>
<td>193</td>
<td>207</td>
<td>184</td>
<td>182</td>
<td>198</td>
</tr>
<tr>
<td>Water absorption 363 hours at 70°C</td>
<td>1,98%</td>
<td>2,20%</td>
<td>2,32%</td>
<td>2,51%</td>
<td>2,15%</td>
<td>2,13%</td>
<td>2,13%</td>
</tr>
<tr>
<td>LOI (%O)</td>
<td>36</td>
<td>38</td>
<td>38</td>
<td>39</td>
<td>39</td>
<td>39</td>
<td>39</td>
</tr>
</tbody>
</table>

EVA-A12.5, EVA-A12.5 and EVA-A37.5 show very effective effect especially on Viscosity, Elongation and LOI.

Vertical burning test (DIN 4102):

Figure 1. Cone calorimeter residues of EVA compounds with MDH and with 12,5 phr of boehmite.

Figure 2. Vertical burning test of EVA-compounds with MDH alone (P1) and boehmite (P4).

Conclusions
Comparison of two different particle size boehmites in combination with MDH:

- the finest one generally takes to better compound properties.
- Characterization of EVA-compounds with combination of boehmites and MDH:
  - increased elongation and decreased viscosity;
  - synergistic FR effects with lower flammability, higher material stability, reduced dropping, better char formation and barrier effect.
- Characterization of PE-based compounds:
  - boehmite with MDH causes no particular synergistic effect in this system.

References

Acknowledgements: TOR Minerals is acknowledged to make ALUPREM TB 1/T and TB DRY available, together with their characteristic properties.