Uses of Alpha Olefin Waxes in Candles

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Process for Making Normal Alpha Olefin Waxes

• CPChem process is a high pressure/high temperature chemistry for making normal alpha olefins.

• Products are separated by distillation.

\[
\begin{align*}
\text{C}_2^2 & \quad \xrightarrow{\text{High pressure}} \quad \text{Even carbon number} \\
& \quad \xrightarrow{\text{Heat, Catalyst}} \quad \text{ethylene oligomers}
\end{align*}
\]
CPChem Normal Alpha Olefins

Available fractions from CPChem:

- 1-butene (1-C₄)
- 1-hexene (1-C₆)
- 1-octene (1-C₈)
- 1-decene (1-C₁₀)
- 1-dodecene (1-C₁₂)
- 1-tetradecene (1-C₁₄)
- 1-hexadecene (1-C₁₆)
- 1-octadecene (1-C₁₈)
- C₂₀-₂₄
- C₂₄-₂₈
- C₂₆-₂₈
- C₃₀+
- C₃₀+ High Alpha
## Comparison of Alpha Olefin Waxes and Paraffin Waxes

<table>
<thead>
<tr>
<th></th>
<th>Normal Alpha Olefin Wax</th>
<th>Paraffin Wax</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon number</td>
<td>Even number only</td>
<td>Odd and even</td>
</tr>
<tr>
<td>Typical Chemical Formula</td>
<td>$C_nH_n$</td>
<td>$C_{n+2}H_{n+2}$</td>
</tr>
<tr>
<td>Isomer distribution</td>
<td>Normal alpha olefin</td>
<td>Linear paraffins</td>
</tr>
<tr>
<td></td>
<td>Linear internal olefin</td>
<td>Branches paraffins</td>
</tr>
<tr>
<td></td>
<td>Vinylidenes</td>
<td></td>
</tr>
</tbody>
</table>

C28H56 Normal Alpha Olefin Wax  
C28H58 Paraffin Wax
Comparison of Alpha Olefin Waxes and Paraffin Waxes

- Normal Alpha Olefin
- Branched Olefin
- Linear Internal Olefin
- Normal Paraffin
- Branched Paraffin
Analysis of Paraffin Waxes

GC analysis

C24 linear paraffin
C25 linear paraffin
C25 branched paraffin
C28 linear paraffin
C28 branched paraffin

125° F Paraffin wax

135° F Paraffin wax
Alpha Olefin Waxes Analysis – by Fraction

C30+ Features

• Color: rich white milky opaque color when solid. Most refinery based paraffin waxes are translucent.

• Appearance: glossy surface; slight marble-like looks. Transfers mold details to the candle. Can provide a high gloss finish.

• Drop melt point: C30+ (~ 170º F) can be used in combination with lower melting point waxes.

• Hard surface: more resistance to scratches than similar paraffin waxes.

• Fragrance retention: higher than similar paraffin waxes.

• Dye dispersion: homogeneous color dispersions.

• Good mold release properties.
C30+ Features

• Color adjustment: CPChem C30+ wax is white when solid. Unlike paraffin waxes it can lighten colors. For example, using a light red dye may form a pink solid candle. When replacing paraffin waxes with C30+, color testing is needed to ensure desired colors.

• Wick compatibility: Performa line of wicks from Atkin and Pearce works well with C30+ in combination with lower melting point paraffin waxes. C30+ has a slow burning rate.

• C30+ is a hard but brittle wax; it is best to use in combination with a softer, lower melting point wax.

• Oil content: C30+ has higher oil content (1.5 %) than most paraffin waxes.
Alpha Olefin Waxes Analysis – by Fraction

C30+ Wax GC Analysis

*Average Carbon Number: C35*
135º F Paraffin Wax and C30+ Wax Blend

GC analysis

C30 linear paraffin + alpha olefin
C32 linear paraffin + alpha olefin
C31 paraffin

135º F paraffin/C30+ (8:2 blend)  135º F paraffin
C30+ High Alpha Features

• High drop melt point: C30+ (~160º F) in small amounts has been used in applications where the high melting point is desirable or in combination with a low melting point wax.

• Appearance: gloss surface; slight marble-like looks. Transfers mold details to the candle.

• Good mold release properties.

• Color: white opaque.

• High gloss finish.
C30+ High Alpha Features

• Color adjustment: CPChem C30+HA wax is white when solid. Unlike paraffin waxes it can lighten up colors. For example, using a light red dye may form a pink solid candle. When replacing paraffin waxes with C30+HA, color testing is needed to ensure desired colors.

• Wick compatibility: Performa line of wicks from Atkin and Pearce works well with C30+HA in combination with lower MP paraffin waxes. Because of its slow burn rate, its concentration in the final product should be less than 20 %, preferably ~ 10 %.

• C30+HA is a hard and brittle wax; it is best to use in combination with a softer, lower melting point wax.

• Oil content: C30+ has higher oil content (4-5%) than most paraffin waxes.
Alpha Olefin Waxes Analysis – by Fraction

C30+ High Alpha Wax GC Analysis

C30 Linear molecule

Average Carbon Number: C36
C24-28 Normal Alpha Olefin Wax

• C24-28 has been used in applications where the high melting point is needed or in combination with a low melting point wax.

• Appearance: gloss surface; slight marble-like looks. Transfers very well the mold details. Can provide a high gloss finish.

• Hard surface: more resistant to scratch than similar MP paraffin waxes. When used in jars, it separates smoothly from the glass.

• Similar properties as to C30+ but lower melting point.

• Color: rich white milky opaque color when solid.

• Good mold release properties.

• Slow burn rate.
C24-28 Normal Alpha Olefin Wax

• It is also brittle like C30+ but because of its lower melting point, it cannot be used in pillar or stand-alone candles but rather in jars and containers.

• This fraction can be used in jar candles. Works well if mixed with C26-28 or other lower melting point waxes.

• Retains more fragrance oils than similar carbon number paraffin waxes.
C24-28 Normal Alpha Olefin Wax GC Analysis

- Average Carbon Number C29

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C26-28 Normal Alpha Olefin Wax

• Lower melting point wax than the other CPChem waxes. Ideal for jar/container applications.

• Appearance and color similar to paraffin waxes of similar melting point.

• Compatible with most wicks.
### CPChem Waxes Properties

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>C24-28</th>
<th>C26-28</th>
<th>C30+</th>
<th>C30+HA</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Saybolt Color</td>
<td>+30</td>
<td>+30</td>
<td>+20</td>
<td></td>
</tr>
<tr>
<td>• Melt Point range, °F</td>
<td>117-130</td>
<td>117-128</td>
<td>142-155</td>
<td>138-145</td>
</tr>
<tr>
<td>• Congeal Point, °F</td>
<td>128</td>
<td>115</td>
<td>155</td>
<td>152</td>
</tr>
<tr>
<td>• Drop Melt Point, °F</td>
<td>154</td>
<td>125</td>
<td>170</td>
<td>160</td>
</tr>
</tbody>
</table>
Using CPChem Alpha Olefin Waxes with Paraffin Waxes

It is best to use CPChem Alpha Olefin Waxes Drop Melt Point as reference guide when blending with paraffin waxes.

•C24-28 has a melting point of 117 to 130°F and a drop melt point of 154°F. It is a harder wax than a 117°F paraffin wax.

  – Presence of the double bonds and
  – Higher Carbon number (C30+) fraction

•C30+ has a melting point of 142 to 155°F and a drop melt point of 170°F. Its properties as a wax for candles are similar to a ~ 160 - 170°F paraffin wax.

  – Presence of the double bonds and
  – Higher Carbon number (C30+) fraction

•C26-28+ properties as a wax for candles are similar to a ~ 125°F paraffin wax.
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>C24-28</th>
<th>C26-28</th>
<th>C30+</th>
<th>C30+HA</th>
</tr>
</thead>
<tbody>
<tr>
<td>•Needle Penetration @ 77° F</td>
<td>95</td>
<td>48</td>
<td>13</td>
<td>5.5</td>
</tr>
<tr>
<td>•Needle Penetration @ 100° F</td>
<td>---</td>
<td>---</td>
<td>24</td>
<td>32</td>
</tr>
<tr>
<td>•Needle Penetration @ 110° F</td>
<td>---</td>
<td>---</td>
<td>34</td>
<td>40</td>
</tr>
<tr>
<td>•Oil content), % (MEK extraction)</td>
<td>4.6</td>
<td>5.0</td>
<td>1.5</td>
<td>4-5</td>
</tr>
</tbody>
</table>
CPChem Waxes Properties

Other Features

• Fragrance compatibility: CPChem waxes are more polar than paraffin waxes, so they tend to better retain fragrances and other polar additives.
  - Homogeneous distribution of the dye and fragrance
  - Lower dye/fragrance settling.

• Cooling rate and temperatures effect: Fast cooling rates increase marble looks for C30+ and increased oil/fragrances retention. Color tent to become lighter.

• Oxidative stability: Addition of antioxidants such as TBHQ and / or BHT increase product stability if stored hot for long periods of time.

• The presence of branched olefins in C30+HA, C30+ and C24-28 alpha olefin waxes cause amorphous morphology.

• Since C26-28 has lower amounts of branched olefins, it has a more plate morphology; similar to refinery based paraffin waxes.
C26-28/C30+ wax blends:
• For a 125-130º F blend, use 88 wt % C26-28 and 11 wt % C30+
• For a 133-138º F blend, use 54 wt % C26-28 and 46 wt % C30+

C26-28/C24-28 wax blends:
• For a 120-125º F blend, use 38 wt % C26-28 and 62 wt % C24-28
• For a 125-130º F blend, use 80 wt % C26-28 and 20 wt % C24-28
Conclusions

• CPChem Alpha Olefin Waxes when used in candle formulations provide:
  — Better fragrance and dye retention than paraffin waxes, forming homogeneous blends.
  — A white opaque color. Most refinery based paraffin waxes are translucent.
  — Alpha olefin waxes provide gloss smooth finish with good mold release properties.

• Blends of C30+ and C30+HA with lower melting point paraffin or alpha olefin waxes can make good candles; always test your formulation to ensure wax/wick/dye/fragrance and container compatibility.

• Blends of C24-28 and other waxes can make good candles; always test your formulation to ensure wax/wick/dye/fragrance and container compatibility.

• Blends of C26-28 with other waxes can make good candles; always test your formulation to ensure wax/wick/dye/fragrance and container compatibility.

• C24-28 and C26-28 can be used in combination or alone with the appropriate wick.
Conclusions

Because there are so many different blend possibilities when using CPChem alpha olefin waxes and other waxes, it is crucial to test for:

- Wax, wick, dye, fragrance, and container compatibility
- Candle burning properties*
  - Fragrance release
  - Flame size
  - Candle color
  - Relighting properties
  - Carbon buildup on the wick

*Call us if you need assistance in using our waxes in your formulations!!!

*As with any candle formulation, testing is required to ensure safe use of the candle by your customer.