CANDLE STANDARDS

A view from Europe

Andrew Leach
Innovation Manager (Project Manager)
SC Johnson, Manufacturing – Frimley Green, UK

Member of Board and Technical Committee of the Association of European Candle Manufacturers

Member of Task Force CEN/BT/TF164 – Candle Safety

---

EUROPE?

- Europe consists of a large number of different countries, with different languages, different cultures, different legal structures.
- 27 of those countries have joined to form the European Union.
- The European Union is a complex organisation!
- CEN is the organisation which co-ordinates the issuance of standards across 30 countries. The members of CEN are the National Standards Bodies of those 30 countries.
CEN CANDLE STANDARDS

There are 3 CEN Candle Standards:

- EN 15494 – “Candles – Product Safety Labels”

As with ASTM standards they are developed by debate between manufacturers, testing laboratories, suppliers, regulatory authorities and other interested parties. Consensus is required within the working group.

The final documents have to be approved by the 30 standards bodies which make up CEN

As with ASTM standards, they are voluntary, but…….
The General Product Safety Directive - GPSD

- The GPSD covers all consumer products not covered by other specific regulations.
- The GPSD requires products to be "safe".
- "……does not present any risk or only the minimum risks compatible with the product’s use, considered to be acceptable and consistent with a high level of protection for the safety and health of persons….."
- The GPSD places the onus on manufacturers and distributors to ensure the safety of products.
- Primarily this should be done using risk assessments.
- Compliance with CEN standards is encouraged, where those standards are applicable.
- Compliance with other standards (such as ASTM) is encouraged, particularly where there is no appropriate CEN Standard
  - Glass jars?
  - Candle Accessories?

RAPEX – The European database of product recalls

- RAPEX was created in 2005 to allow the EU enforcement authorities to share data about product recalls across the 27 countries.
- It is a public database and is easy to access and search.
- It is located at:
- You can see that some recalls already mention non compliance with EN 15493.
- You should also notice that several recalls quote non compliance with Directive 87/357/EEC – by Imitating Food. Many EU countries are strict about this.
EN 15494. Candles – Product Safety Labels.

- Requires labelling to be “visible and legible” but does not restrict where it has to placed.
- If appropriate can be provided at point of sale in form of a leaflet.
- Allows use of agreed phrases or pictograms.
- Requires use of General Warning Sign (in accordance with ISO 3864-2) Yellow background is recommended.
- Warnings may be in form of:
  - Words – “Supplementary safety information text”.
  - Pictograms – “Supplementary safety information symbol”
- Pictograms are based on those which have been used in Europe for many years.

There are 4 mandatory warnings:

- Never leave a burning candle unattended.
- Burn candle out of the reach of children and pets.
- Always leave at least xx cm between burning candles.
- Do not burn candles on or near anything that can catch fire.
There are 11 optional warnings - to be selected according to risk assessment. (Please don’t use them all on one candle!!!)

- Do not place candles in a draught
- Do not place candles near a source of heat.
- Place candles in an upright position.
- Trim wick to about 1 cm before lighting

Always snuff out the flame. Do not blow it out.

Always use a candleholder

Keep the wax pool clear of matches and other debris to avoid flaring

Only use tea light in holders and warming stoves with sufficient ventilation.
EN 15494. Candles – Product Safety Labels.

- There are 11 optional warnings - to be selected according to risk assessment. (Please don’t use them all on one candle!!!)
- Do not move a burning candle.
- Use a suitable container as these candles liquify when burning.
- Never use liquid to extinguish.

EN 15493. Candles – Specification for Fire Safety

- Is broadly similar to ASTM F2417
- Generally 4 hour burn cycles – this was decided specifically to match F2417.
- Spacing of candles during test should match the manufacturer’s instructions required in EN 15494.
- Lower flame height requirement for tea-lights (30mm)
- Extra requirement – “The wick shall not continue to glow or smoke for more than 20 s after extinguishing. After extinguishing the candle the candle shall not spontaneously re-light”
**EN 15426 – “Candles – Specification for Sooting Behaviour”**

- “This European Standard describes the requirements and a simple method for measuring the sooting behaviour of candles. The soot index obtained by this procedure may be considered as characteristic of the sooting behaviour of the type of candle tested.

- The soot which is emitted from a candle is collected on a glass plate throughout a defined period. Afterwards the attenuation of light intensity caused by soot precipitation is quantified in a measuring chamber.

- This method helps to ensure a reasonable degree of safety for normal use, thereby improving personal safety.”

---

**Why test for soot? Let's look at the Flame.**

- Zone 4. Non-Luminous Zone: O₂ surplus
- Oxidation of soot particles
- Zone 3. Light Yellow, bright zone; pyrolysis progresses, soot particles increase
- Zone 2. Dark Zone, pyrolysis, formation of primary soot particles
- Wick burns and is slowly consumed.
- Zone 1. Bright blue zone: O₂ surplus, paraffin wax burns
- Non-luminous zone: paraffin wax evaporates
- Liquid paraffin wax is drawn up the wick
Why test for soot? The Chemistry

All of these processes require heat. In addition the carbon has to be heated until it is incandescent and can be oxidised.

So, what is the primary source of this energy?

Reaction of Oxygen with Hydrogen and the Incandescent Carbon
Complete Combustion

- The system (formula, shape, wick) is under control.
- Sufficient energy has been created to raise all the soot to incandescence so it can be oxidised.

Incomplete Combustion

- The wick is too big/strong, so that the fuel flow is too great?
- There is insufficient energy to raise the soot to incandescence (1000°C)?
- Draught?
- The ratio of hydrogen to carbon is too low?
- Too many “complex” molecules in the fuel, requiring extra energy for pyrolysis?
- There is incomplete combustion.
- The system is not in control.
How to measure soot – just look!

- **good**
- borderline case
- **bad**

non sooting  
low sooting  
sooting

**How to measure soot**

- White Tile
- White Card
- White paper

  - Compare level of grey against a standard scale.
  - *Largely replaced by ASTM and EN standards, but still valid.*
How to measure soot

- ASTM F 2326 - 04 (REAPPROVED 2009)
- STANDARD SPECIFICATION FOR COLLECTION AND ANALYSIS OF VISIBLE EMISSIONS FROM CANDLES AS THEY BURN

- wire mesh
cylinder

- glass plate
detector unit

EN 15426 - 2007
Candles – Specification for sooting behaviour.

- closed
- open
How to measure soot

- EN 15426 - 2007
  - Candles – Specification for sooting behaviour.
  - Defines a method which is similar in principle to ASTM F2326 04
  - BUT, also includes a specification for a pass/fail:
    - A “Soot Index” of 1 per hour.

What does a soot index of 1/hour look like?

<table>
<thead>
<tr>
<th>Category</th>
<th>Soot Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>non sooting</td>
<td>&lt; 1/h</td>
</tr>
<tr>
<td>low sooting</td>
<td>1/h – 1.5/h</td>
</tr>
<tr>
<td>sooting</td>
<td>&gt; 1.5/h</td>
</tr>
<tr>
<td>borderline case</td>
<td>Soot Index 1/h – 1.5/h</td>
</tr>
</tbody>
</table>
What does that look like on the glass plate?

How to measure emissions
The Ökometric Study into Emissions from Candles.

**Standard vs. Sooting Candles**

**Composition and Soot Index**

- **Standard Candles**
  - Paraffin
    - Wax – IGI Paraflex 4786
    - Wick – WEDO LX10
    - Burn rate – 4.2 gr/hr
    - Soot Index – 0.3
  - Soy
    - Wax – NatureWax C3
    - Wick – WEDO ECO2
    - Burn rate – 4.2 gr/hr
    - Soot Index – 0.1

- **Sooting Candles**
  - Paraffin
    - Wax – IGI Paraflex 4786
    - Wick – WEDO LX20
    - Burn rate – 6.5 gr/hr
    - Soot Index – 2
  - Soy
    - Wax – NatureWax C3
    - Wick – WEDO 3x30 SU
    - Burn rate – 7.6 gr/hr
    - Soot Index – 4
### Standard vs. Sooting Candles

#### Dioxins and Furans (PCDD/PCDF) as WHO-TEQ

<table>
<thead>
<tr>
<th></th>
<th>Standard Candles</th>
<th>Sooting Candles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paraffin</td>
<td>0.0336 pg TEQ/hr</td>
<td>0.3705 pg TEQ/hr</td>
</tr>
<tr>
<td>Soy</td>
<td>0.0378 pg TEQ/hr</td>
<td>0.2584 pg TEQ/hr</td>
</tr>
</tbody>
</table>

#### PAHs

*Sample analysed for 13 different compounds*

<table>
<thead>
<tr>
<th></th>
<th>Standard Candles</th>
<th>Sooting Candles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paraffin</td>
<td>15.59 ng/hr</td>
<td>101.31 ng/hr</td>
</tr>
<tr>
<td>Soy</td>
<td>14.12 ng/hr</td>
<td>105.43 ng/hr</td>
</tr>
</tbody>
</table>
### Standard vs. Sooting Candles

#### Short Chain Aldehydes


- **Standard Candles**
  - Paraffin: 2.77 µg/hr
  - Soy: 8.99 µg/hr

- **Sooting Candles**
  - Paraffin: 38.48 µg/hr
  - Soy: 41.8 µg/hr

#### VOCs

*Total of 285 compounds targeted.*

- **Standard Candles**
  - Paraffin: 17.14 µg/hr
  - Soy: 12.89 µg/hr

- **Sooting Candles**
  - Paraffin: 18.46 µg/hr
  - Soy: 13.60 µg/hr
Based on these results (and the results in some previous German studies) there does appear to be a correlation between the visible and invisible emissions.

Selecting the best wick is key

- The wick is the control of the burning process in any candle system.
- The wick determines the fuel flow.
- The fuel flow determines the flame size.
- The fuel flow determines the carbon concentration in the flame.
- The fuel flow influences sooting behaviour.
Soot Testing – In Summary

- A candle is a system.
- Emissions of significant amounts of soot are an indication that the system is out of control.
- Emissions of soot indicates incomplete combustion which suggests the candle will emit higher levels of other hazardous materials (e.g. Dioxins, PAH ...)
- Soot testing is simple, inexpensive and can be carried out by any candlemaker.

⇒ The soot test is a ‘HEALTH-CHECK’ for a candle.

CEN Soot Test Equipment

- Further information about the equipment required to undertake the CEN Soot Test Standard can be obtained from:

  http://www.heilmetalle.com/english/index_e.html
MY THANKS TO:

- Michael Matthaei previously with Sasolwax and now Managing Director of WEDO wick.
- Helmut Gutberlet and colleagues at Sasolwax
- Rob Harrington of Blyth Corporation.
- So many other friends in the Candle Industry.

- And, of course to you for listening!