

# Characterization of Particle Emissions from Candles



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# Particle pollution of our indoor environment



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- Causes declining public health with an estimated annual loss of more than 2 million healthy life years within the EU
- Airborne particles in private homes can originate from e.g. fire stoves, cooking or **candle burning**

Every Dane annually consumes  
nearly 6 kg of candles



# Comprehensive survey



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- Survey and Risk Assessment of Particle and Heavy Metal Emissions from Candles, No. 157, April 2017
- 129 different candles identified
- Report available here:
  - <https://goo.gl/uyc8zM>



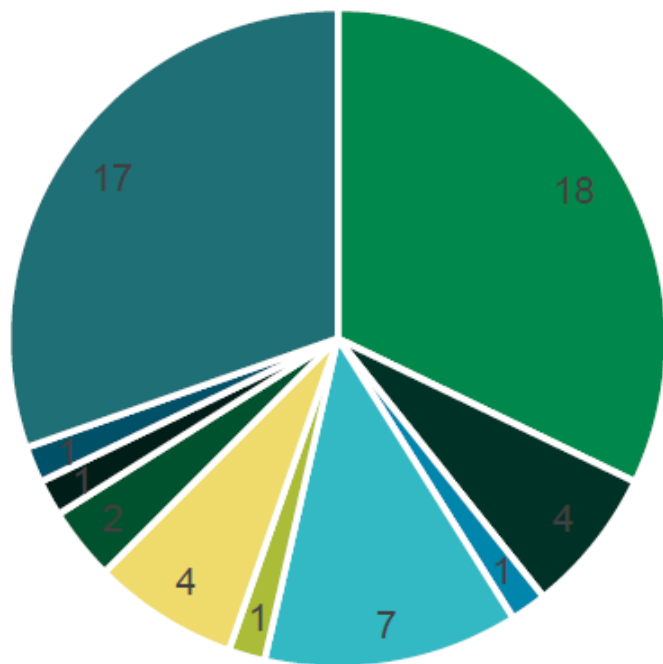
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# Wax types of 56 different brands

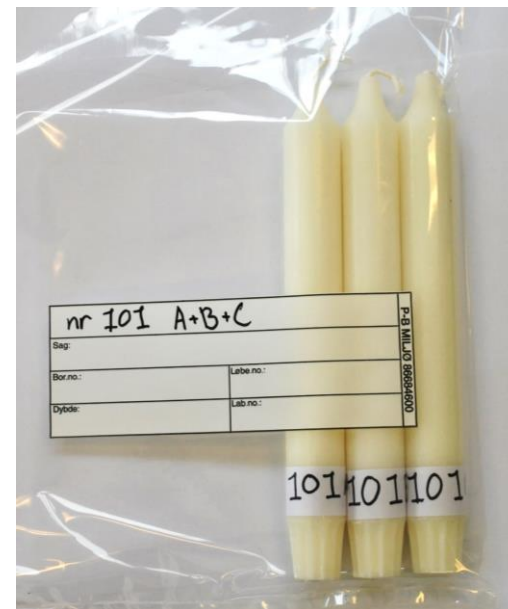


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- 100% pure stearin
- Not pure stearin
- Stearin
- Paraffin
- Paraffin/vegetable wax
- Fully refined special wax
- Palm oil
- Beeswax
- Recycled candles
- Unknown

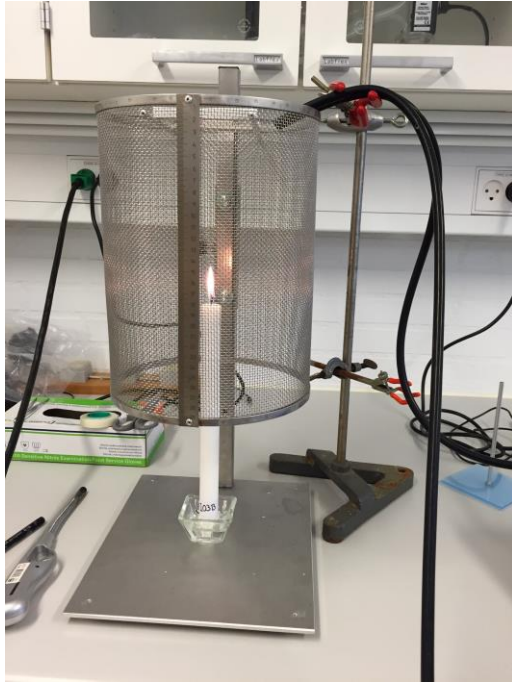
32 white candles selected



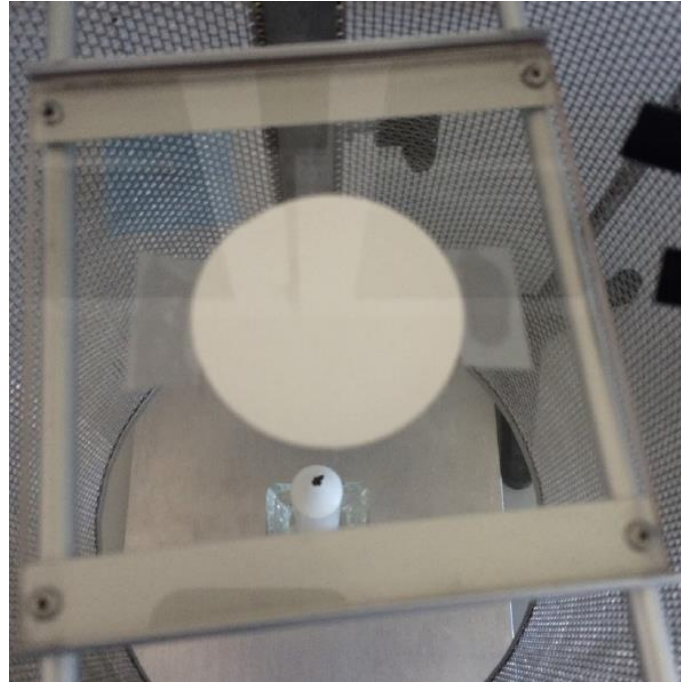
# Measurement setup



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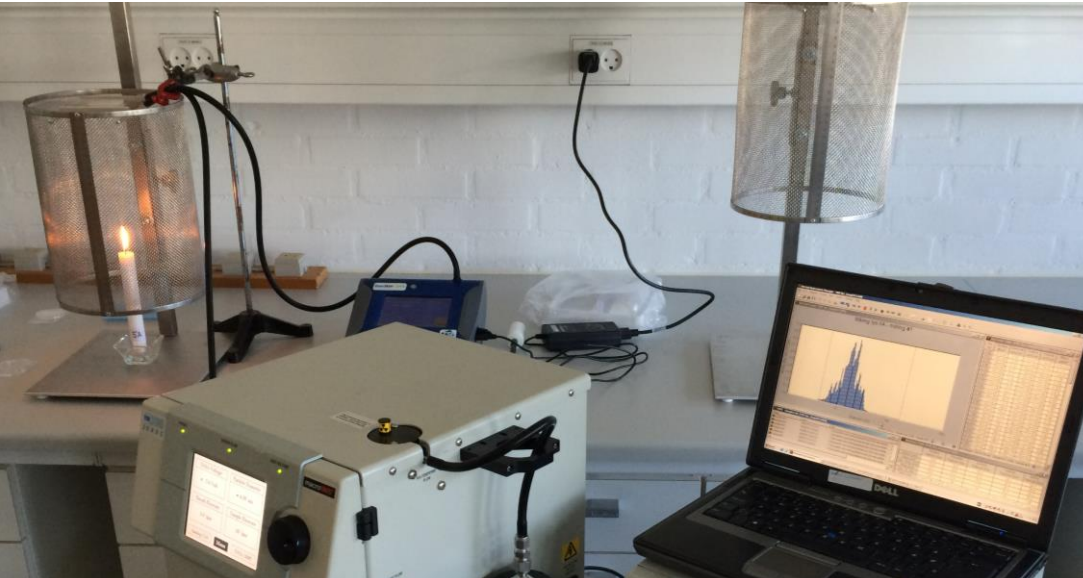
EN15426



Analysis of nickel and lead content



# Measurement equipment



## Scanning mobility particle sizer (SMPS)

- Particle Number (PN)
- Size distribution (PSD)
- Size range with nanoDMA: 4.4-166 nm

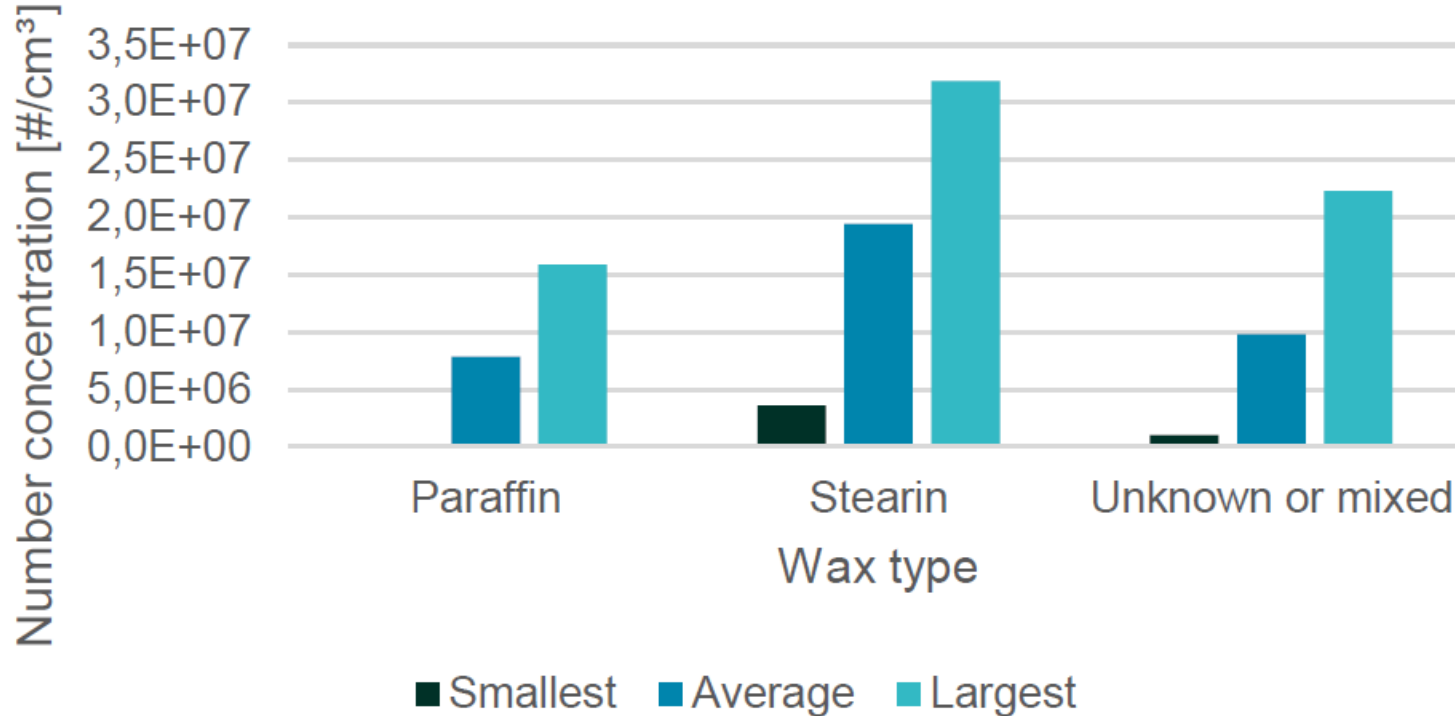
## DustTrak – Particle Mass (PM)

| 1 hour                      | 21 minutes  | 30-60 minutes                    |
|-----------------------------|-------------|----------------------------------|
| Lighting and stable burning | Measurement | Putting out and background level |

# PN emission vs. wax type



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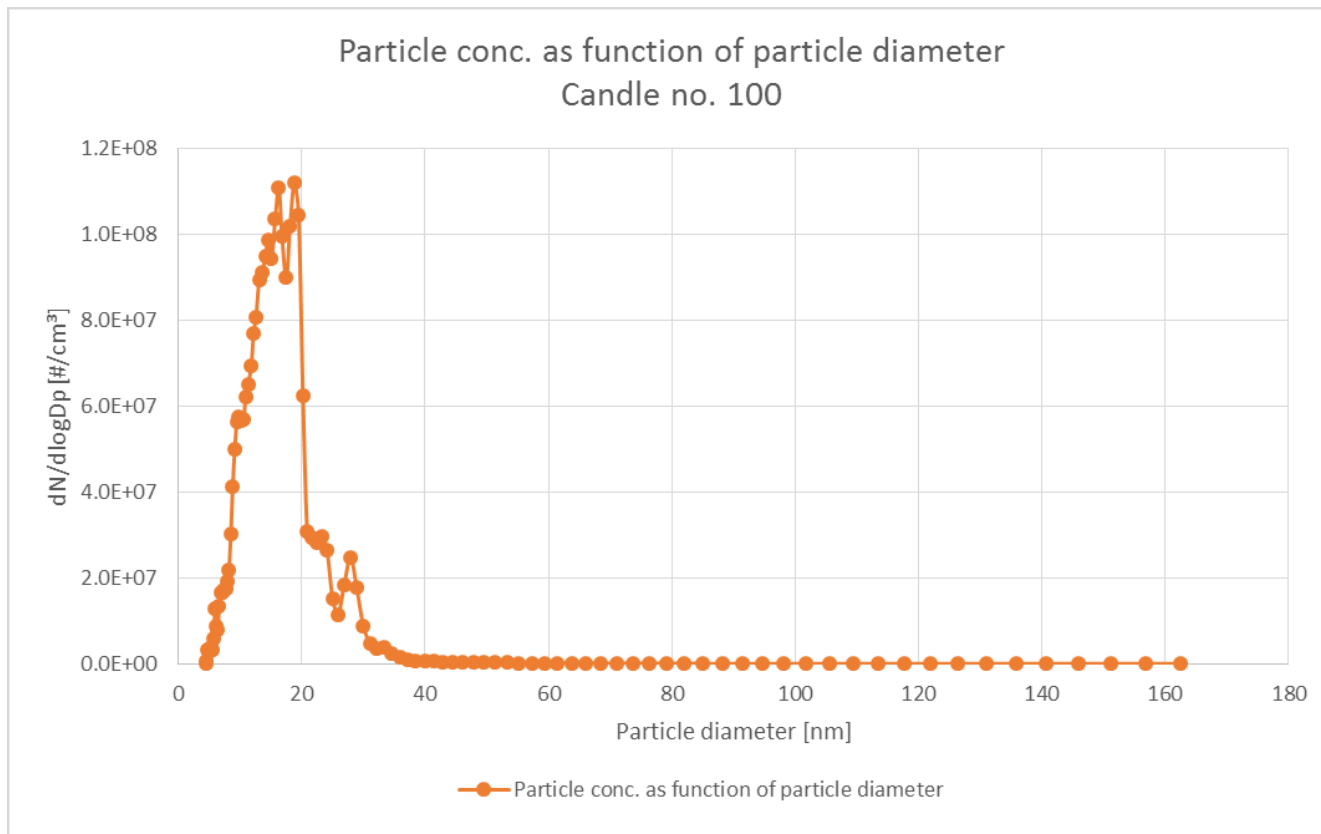




# Average size: 7 nm to 18 nm



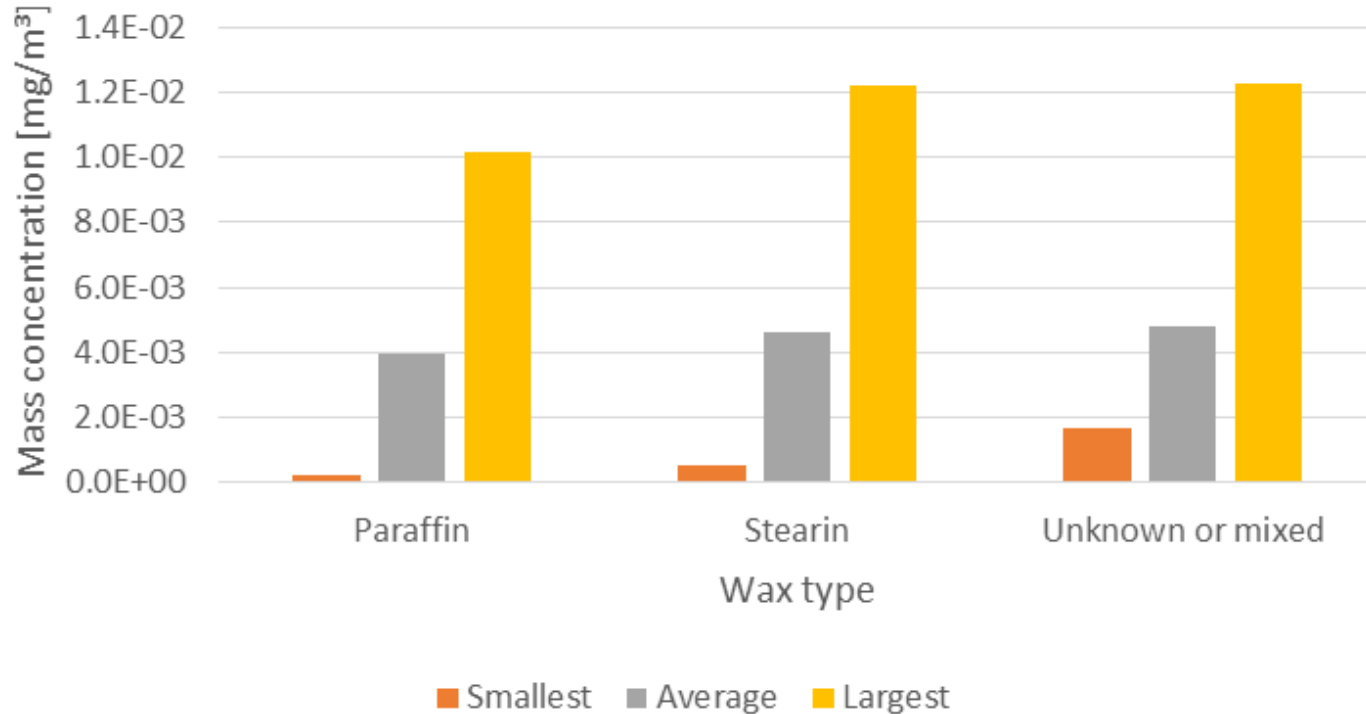
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# PM emissions *vs.* wax type



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# Emissions in the room



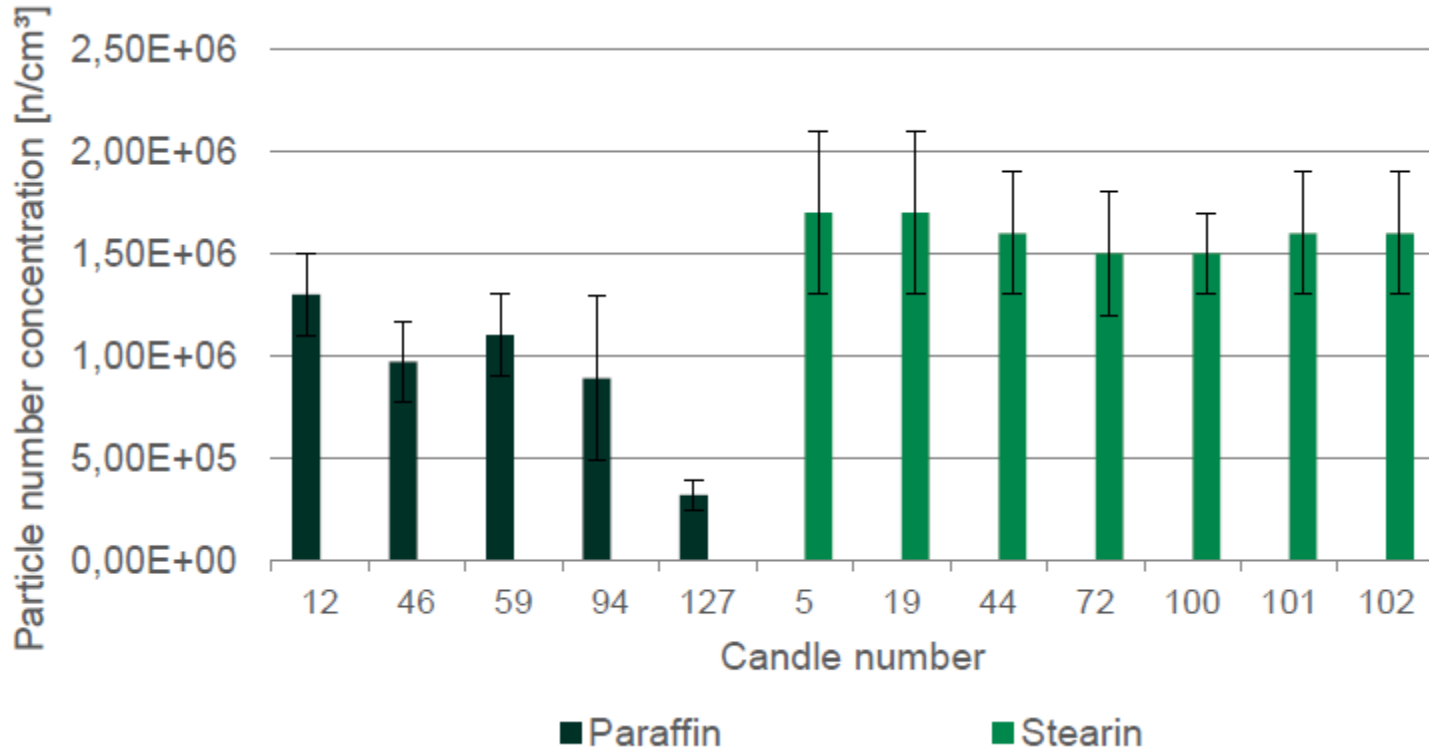
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- Analysis of candles of stearin wax and paraffin wax
- 2 candles of same type burned simultaneously
- 2 measurement stations used – each  $\sim 1.5$  m from the candles

# PN emissions – room measurements



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A lit candle is shown on a dark wooden surface. The candle is melting, with a pool of wax at its base. Three callout boxes point to different parts of the candle: the smoke rising from the flame, the wax pool, and the wick. Each box contains data on lead and nickel levels.

### Passive sampling

Lead: 2/32

Nickel: 3/32

### Wax

Lead: 4/32

Nickel: 2/32

### Wick

Lead: 26/32

Nickel: 9/32

Detection limits:  
0,05 µg/filter and 0,05 mg/kg

# Conclusions



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- Emission from stearin wax is measured to be a factor of 2 higher than the emission from paraffin
- The emission from a sooting candle can be 30-70 times higher than the emission from a non-sooting candle
- Highest priority should be given to selecting candles that burn with a steady and non-sooting flame
- Measured levels of lead and nickel are very low, thus exposure levels of concern are not to be expected



# Outlook



**Ministry of Environment  
and Food of Denmark**  
Environmental  
Protection Agency

- 2016-2018
- Development of low-emission candles by investigating new types of wax and wicks

## Poster 24



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### Characterization of particle emissions from candles

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#### Introduction

Danes have the highest consumption of candles in the EU, averaging 3.8 kg per person per year. This results in an increased concentration of particles in the indoor environment and potential health hazardous effects.

#### Aim

The objective was to get an impression of the particle emission from candles with a focus on respirable and ultrafine particles. Additionally, the amount of lead and nickel emitted from burning candles was quantified, and it has been clarified if a health related risk is involved when staying in a room with the investigated candles burning.

#### Methods

Initially, 123 different candles were identified on the Danish market, and among these 32 white candles were chosen for particle emission measurement and chemical content analysis.

The following methods were used:

- Particle number (PN) and size distribution (PSD) measured by TSI scanning mobility particlesizer (SMPS)
- Particle mass measured by TSI DustTrak
- Filter sampling for subsequent chemical analysis of emitted particles for content of lead and nickel

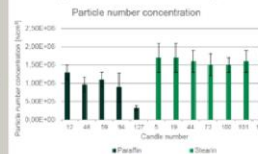
The candles were placed in a wire screen (EN 15426) and particle emissions were measured close to the candle and in the room. All measurements were carried out in a climate room.



#### Emission and chemical content

Two candles from each of the 32 candle types were analysed.

- Stearin candles generally emit twice as many ultrafine particles as paraffin candles (both source and room measurement)
- In the wick, lead was identified in 26 candle types and no nickel could be identified. In the wax, lead was identified in 4 candle types, and nickel was found in 2 candle types



#### Risk assessment

It is very uncertain to conclude that stearin candles are more critical than paraffin wax candles. More knowledge of the composition of the particles and additional toxicity data are required.

#### Conclusions

The burning circumstances are considered to be of greater significance than whether the candle is a stearin candle or paraffin candle. Therefore, highest priority should be given to selecting candles that burn with a steady and non-sooting flame.

A sooting candle can emit 30-70 times as many particles to the air compared to a non-sooting candle.

- White candles amounts to approximately 90% of the entire sale of candles on the Danish market.
- During winter season, 6 out of 10 Danes daily or several times per week burn candles at home.
- <http://mst.dtu.diveris/publication/publicationmark/2017/mst-diveris-risk-assessment-of-particle-and-heavy-metal-emissions-from-candles/>



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