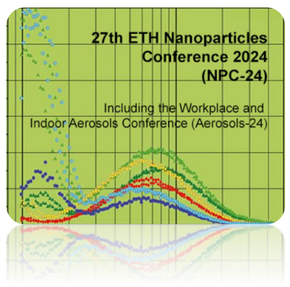

Healthy Indoor Environment

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Indoor particle pollution from cooking

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Background

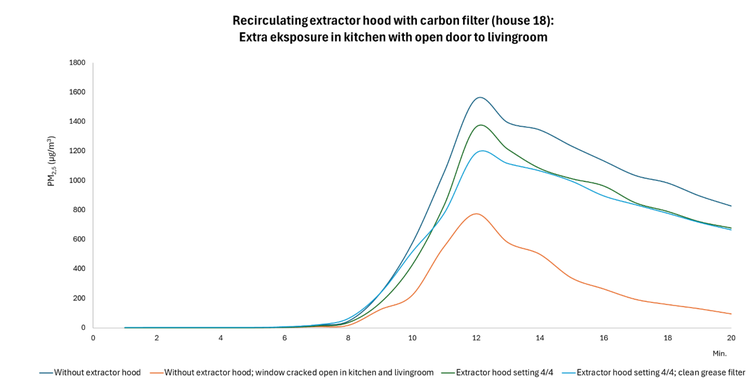
In most developed countries, people spend most of their lives in their homes, where particle pollution from food cooking is a significant pollution source. The pollution increases the risk of cancer, cardiovascular diseases, blood clots and respiratory disorders. Powerful extractor hoods with external discharge are efficient solutions. However, our hypothesis is that many families still do not have installed powerful extractor hoods (especially not in apartments) and that recirculating extractor hoods (with activated carbon filters) are inefficient.

Purpose

The purpose was to investigate how efficient extractor hoods are in 20 Danish homes and if they are used correctly.

Methods

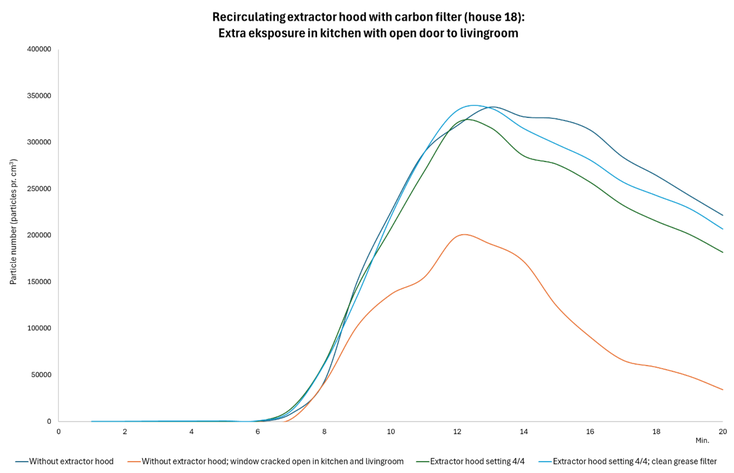
Particle measurements (PN and $PM_{2.5}$ with calibrated P-Traks and DustTraks from TSI), ventilation calculations and in-depth interviews in 20 representative Danish homes with extractor hoods: 7 detached houses with a traditional separate kitchen, 3 newer detached houses with a combined kitchen and living room (modern style), 10 apartments of which 7 apartments have recirculating extractor hoods with activated carbon filters (often used in apartments). In each measurement, we used a carefully developed bacon test-setup (sliced bacon: average weight 21.43g/slice, 3 slices/setup; fried on our transportable cooking plate: Esperanza 2-burner induction plate, St. Maria, Intelligent induction extractor; using a new clean pan (Fiskars Rotisser+Optiheat Technology) to gain homogeneous pollution. The method is robust enough to decide whether the requirement of the Danish building code of min. 75% removal of pollution is achieved. The following set-ups were measured: 1) Without the use of the extractor hood; 2) with the extractor hood on the level typically used by the family; 3) with the extractor hood on the highest level; 4) with the extractor hood on the highest level + cleaned grease filter. All measurements were carried out parallel in the kitchen and the connected room in separate measurement rounds with either open or closed door to the kitchen. Further setup adjustments were made and depending on the type of residency, different setups were made to see if natural ventilation could be an alternative to the extractor hood: 1) with window(s) cracked open in the kitchen; 2) with windows cracked open in the kitchen and connected room causing some through draught; 3) with window(s) wide open in the kitchen. In total, around 150 measuring situations were made (aeration between each measurement). A ventilation fan (adjusted to non-heating) was used in the kitchen to ensure fully mixed air. Finally, acoustic and flow measurements of the extractor hood during the extractor hoods' various operating levels were made. Candles, tobacco smoking, wood stoves, vacuum cleaning or other activities that could generate air pollution inside the house were avoided during measurements.



Key findings

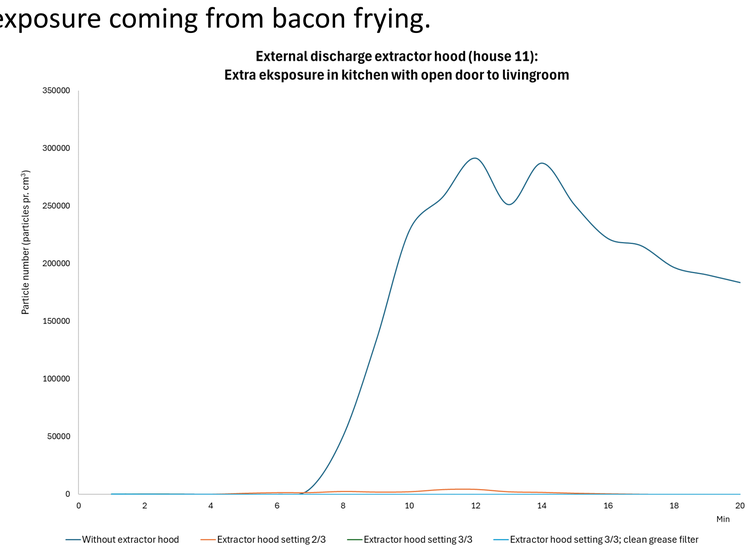
Our investigations revealed the following:

- Most of the families do not close the door(s) to the kitchen – Keeping the door(s) closed to the kitchen is important to prevent pollution from spreading to the rest of the home.
- Recirculating extractor hoods do not remove the pollution.
- Extractor hoods with external discharge can efficiently remove the pollution from bacon frying and thereby significantly reduce particle pollution in the house and easily fulfill the Danish building code of min. 75% removal.
- The middle or high setting on extractor hoods with external discharge have often almost similar removal efficiency.



- Insignificant differences of pollution removal is seen when using a clean versus dirty grease filter.
- Windows cracked open with some through draught is to some extent lowering pollution levels. A window wide open in the kitchen during and after cooking keeps pollution levels low (door closed to the kitchen): Half of the families either have through draught or a window/door wide open in the kitchen when cooking.
- For most families, the type of food is decisive for the level on which the extractor hood is used.
- Most families find their extractor hood noisy, which affects their use of the extractor hood in several cases.
- Most families are aware of the health consequences of particle pollution from food cooking.
- Most families were not advised on efficiency and noise when buying their extractor hood.
- In most families, the extractor hood is not used consistently when cooking
- Only one family turns on the extractor hood before starting cooking – Most families turn on the extractor hood when they turn on the stove/oven, while a fair share turns on the extractor hood while cooking.
- Most families have an oven elsewhere than under the extractor hood.
- All families with recirculating extractor hood experience disturbing smell after cooking, whereas for families with external discharge extractor hoods are 50-50 split on that matter.
- Toasters, air fryers, etc. are typically used without the use of an extractor hood.

In the tables and graphs are shown the average extra exposure coming from bacon frying.



Average extra exposure in house 18: Recirculating extractor hood (setting 1-4) in a kitchen of 8,83 m².

	Open door to kitchen				Closed door to kitchen			
	Kitchen counter		Livingroom table		Kitchen counter		Livingroom table	
	$PM_{2.5}$ (µg/m³)	PN (pr. cm³)	$PM_{2.5}$ (µg/m³)	PN (pr. cm³)	$PM_{2.5}$ (µg/m³)	PN (pr. cm³)	$PM_{2.5}$ (µg/m³)	PN (pr. cm³)
Without extractor hood	617	167,590	13	5,000	767	174,240	0	0
Without extractor hood, kitchen window cracked open	---	---	---	---	329	126,690	0	230
Without extractor hood, kitchen window wide open	---	---	---	---	115	52,570	0	420
Without extractor hood, kitchen + living room window cracked open	198	71,192	35	12,410				
Extractor hood setting 2/4	546	165,960	17	7,370				
Extractor hood setting 4/4	507	149,270	21	7,350				
Extractor hood setting 4/4, cleaned grease filter	495	161,180	18	7,570				
Air quality guidelines	15 [1)]	20,000 [2)]	15 [1)]	20,000 [2)]	15 [1)]	20,000 [2)]	15 [1)]	20,000 [2)]

PN: Particle number. 1) WHOs air quality guideline daily av. 2) WHOs target for high particle number (hourly av.).

Average extra exposure in house 11: External discharge extractor hood (setting 1-3) in a kitchen of 6,1 m².

	Open door to kitchen				Closed door to kitchen			
	Kitchen counter		Livingroom table		Kitchen counter		Livingroom table	
	$PM_{2.5}$ (µg/m³)	PN (pr. cm³)	$PM_{2.5}$ (µg/m³)	PN (pr. cm³)	$PM_{2.5}$ (µg/m³)	PN (pr. cm³)	$PM_{2.5}$ (µg/m³)	PN (pr. cm³)
Without extractor hood	994	138,270	57	7,070	1,814	174,250	0	38
Extractor hood setting 2/3	8	1,170	1	130	---	---	---	---
Extractor hood setting 3/3	0	0	0	0	---	---	---	---
Extractor hood setting 3/3, cleaned grease filter	0	0	0	0	---	---	---	---
Air quality guidelines	15 [1)]	20,000 [2)]	15 [1)]	20,000 [2)]	15 [1)]	20,000 [2)]	15 [1)]	20,000 [2)]

PN: Particle number. 1) WHOs air quality guideline daily av. 2) WHOs target for high particle number (hourly av.).

Further info

Healthy Indoor Environment: www.en.godtindeklima.nu

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