Sources, behaviour and mitigation strategies influencing indoor air quality

Dr Stephanie Gauthier (University of Southampton, UK)
Dr Vicki Stevenson (Cardiff University) Dr Archit Mehra (University of Chester) Dr Zaheer Nasar (Cranfield University) Dr Stefano Rolfo (STFC) Dr Alejandro Moreno Rangel (Lancaster University) Dr Jo Zhong (Nottingham Trent University) Dr Rob Ferguson (University of Essex) Dr Douglas Booker (NAQTS)
23rd September 2021
Indoor air quality

- Average UK person spends 90% time indoor
- High exposure to indoor air pollutants:
  - particulate matter
  - volatile organic compounds
  - carbon monoxide
  - biological materials
Sources of pollution
Behaviour: cooking

- UK Time Use Survey to establish frequency & duration of behaviour

![Graph showing cooking activity times]

- 8:00 for 15 min
- 12:30 for 20 min
- 17:30 for 20 min

![24h (4am to 4 am) - Ten minutes intervals]

Number of reported activity:

- 0
- 200
- 400
- 600
- 800
Behavior: cleaning

- UK Time Use Survey to establish frequency & duration of behaviour

![Graph showing activity distribution with peak at 9:50 for 25 min]
## Behaviour: typical schedule for a day

<table>
<thead>
<tr>
<th>Activity</th>
<th>Time</th>
<th>Duration (mins)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cooking</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breakfast – Toast &amp; Tea</td>
<td>08:00 – 08:16</td>
<td>16</td>
</tr>
<tr>
<td>Leave the room</td>
<td>08:16 – 09:10</td>
<td></td>
</tr>
<tr>
<td><strong>Washing up</strong></td>
<td>09:10 – 09:25</td>
<td>15</td>
</tr>
<tr>
<td>Leave the room</td>
<td>09:25 – 09:50</td>
<td></td>
</tr>
<tr>
<td>Cleaning the dwelling</td>
<td>09:50 – 10:15</td>
<td>25</td>
</tr>
<tr>
<td>Leave the room</td>
<td>10:15 – 12:30</td>
<td></td>
</tr>
<tr>
<td><strong>Cooking</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pasta – low emission</td>
<td>12:30 – 12:48</td>
<td>18</td>
</tr>
<tr>
<td>Leave the room</td>
<td>12:48 – 13:30</td>
<td></td>
</tr>
<tr>
<td><strong>Washing up</strong></td>
<td>13:30 – 13:46</td>
<td>16</td>
</tr>
<tr>
<td>Leave the room</td>
<td>13:46 – 17:30</td>
<td></td>
</tr>
<tr>
<td><strong>Cooking</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stir fry - High emission</td>
<td>17:30 – 17:53</td>
<td>23</td>
</tr>
<tr>
<td>Leave the room</td>
<td>17:53 – 18:40</td>
<td></td>
</tr>
<tr>
<td><strong>Washing up</strong></td>
<td>18:40 – 18:57</td>
<td>17</td>
</tr>
</tbody>
</table>
Question:

What would be the particulate emission from these two dishes under different ventilation scenarios?
Mitigation strategies

• Reduce behaviours – cooking, cleaning, solid-fuel fires, use of candles, smoking, etc.
• Choose low emission materials
• **Increase ventilation**

Reference: NICE (2020) Improving indoor air quality
Tests

4 tests:

• two days *low* ventilation (Tue 6th & Wed 7th July 2021)
• two days *high* ventilation (Thu 8th & Fri 9th July 2021)

Measures: T, RH, $V_a$, $CO_2$, $NO_x$, $PM_1$, $PM_{2.5}$, $PM_{10}$, $O_3$, TVOC, $CH_4$, irradiance, bioaerosol

Early Results – PM10

Day 1

Day 2

Day 3

Day 4

µg/m³
Early Results – PM10

Low ventilation

μg/m³

0 200 400 600 800 1000 1200
Early Results – PM10

μg/m³

0 200 400 600 800 1000 1200

Stir fry

Toasts  Pasta  Stir fry

Stir fry

Toasts  Pasta  Stir fry
Conclusions

Exposure is linked to

• Behaviour: type, duration, frequency
  stir fry cooking (344 μg/m³/20min) = 19.2 * pasta cooking (18 μg/m³/20min)

• Ventilation practices
  low ventilation (daily mean 20.4 μg/m³) = 2.6 * high ventilation (daily mean 7.7 μg/m³)

WHO 09/2021 15 μg/m³ annual mean & 45 μg/m³ 24-hour mean