WHO Household Multiple Emission Sources (HOMES) and Performance Target (PT) Model: Input Parameter Protocol – Kitchen Volume

February 2020
Version 2.3

Acknowledgements: This protocol was prepared by Berkeley Air Monitoring Group for the World Health Organization. Please contact householdenergy@who.int with any questions. We are grateful for input and review from colleagues at Colorado State University, Lawrence Berkeley National Laboratory, United States Environmental Protection Agency, the Global Alliance for Clean Cookstoves, Aprovecho Research Center, University of California Berkeley, Columbia University, and Mountain Air Engineering.

Model Parameter: Room (kitchen) volume

Objective

Measure and calculate the room volume where the emissions source(s) is/are present, generally the kitchen.

Background and context

Kitchen volume is generally straightforward to measure and can be assessed relatively rapidly with simple equipment. For the purposes of the WHO Household Multiple Emission Sources (HOMES) and Performance Target (PT) Models, the **kitchen** is defined as an indoor room with four walls and a ceiling. Thus, this protocol can also be used to calculate the volume of a different room if that is where the emission source is used (e.g., living room or secondary kitchen in the case of measuring emissions from a device like a combined cooking-heating stove). The volume should include the entire space that is not separated by a barrier such as a door or wall, even if that includes a living or sleeping area. In cases where this separation is not clear, a rule of thumb is that at least 50% of a wall must be open to another room to consider that room as part of the kitchen. The following steps provide instructions for measuring room volumes of simple rectangular or circular rooms. If a room has a different shape, then the volume should be calculated according to the geometry of that space.

Equipment required

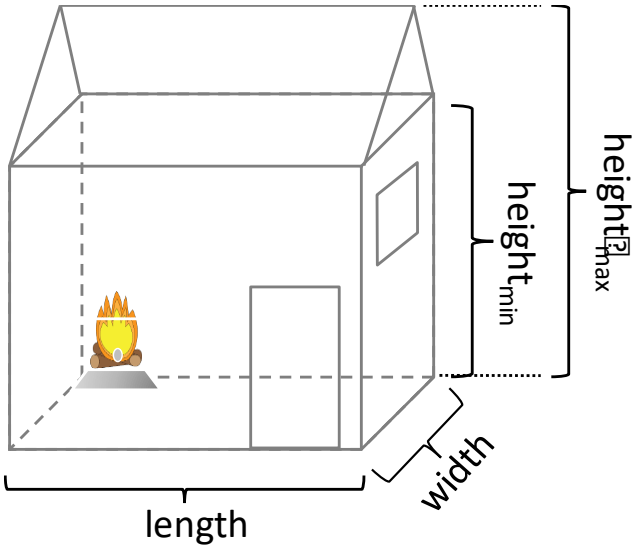
- Measuring tape
- Sonic distance meter (optional)
- Stepstool or ladder (optional)

Procedure

1) Determine the shape of the room. If the kitchen is rectangular, follow the steps in "a)"; if the kitchen is circular, follow the steps in "b)". If the shape of the kitchen requires a different calculation (e.g., if the kitchen has a trapezoidal roof or multiple rectangular volumes), then the geometries should be calculated as necessary specifically for that kitchen.

    a) Use the measuring tape to measure the following dimensions for a **rectangular kitchen**:
        i) Kitchen length – from front to the back
        ii) Kitchen width – from side to side
        iii) Minimum height – minimum distance from ceiling to floor
        iv) Maximum height – maximum distance from ceiling to floor
        v) The volume can then be calculated as:

$$Volume \ = \ length * width * \left[\frac{max\ height \ + \ min\ height}{2}\right]$$



or, separating the rectangular box portion of the room from the ceiling portion in the case of a gable roof (slanted on sides and flat on top),

$$Volume = length * width * min\ height + \frac{1}{2}(length * width * (max\ height - min\ height))$$

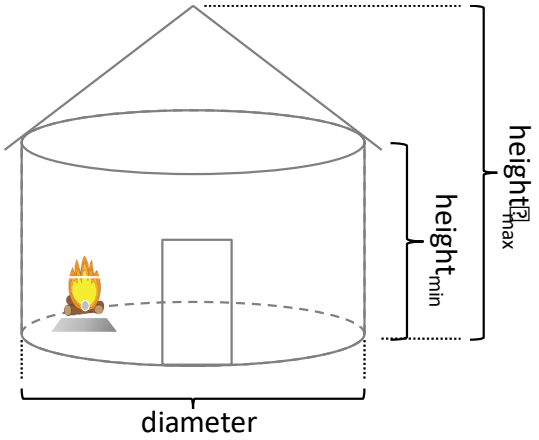
As an example, suppose the dimensions are measured as below:

Dimension	**Value (meters)**
Length	5
Width	3
Min height	2.4
Max height	3

$$Kitchen\ volume = 5 * 3 * \left[\frac{3 + 2.4}{2}\right] = 40.5\ m^3$$

b) Use the measuring tape to measure the following dimensions for a **circular kitchen**:
   i) Kitchen diameter
   ii) Minimum height – minimum distance from ceiling to floor
   iii) Maximum height – maximum distance from ceiling to floor
   iv) The volume can then be calculated as:

$$\text{Volume} = \pi\, x \left[\frac{\text{diameter}}{2}\right]^2 * \left[\text{min height} + \left[\frac{\text{max height} - \text{min height}}{3}\right]\right]$$



The following presents an example with sample measurements:

Dimension	Value (meters)
Diameter	5
Min height	2.4
Max height	3

$$Kitchen\ volume = \pi * \left(\frac{5}{2}\right)^2 * \left(2.4 + \frac{3 - 2.4}{3}\right) = 51.1\ m^3$$

Tips

- The most difficult measurement is often the maximum height in a tall kitchen. A sonic or laser measuring device can be very useful for this measurement as it does not require stretching a tape to the top of the ceiling. If using a regular measuring tape, take care if using a chair or ladder. In extreme cases or if the measurement does not need to be precise, an estimate of height can be made by measuring what appears to be half way to the top and doubling that height.
- If the floor or ceiling is somewhat uneven, attempt to take the measurement from what appears to be the average height in the room.

It helps to have two people – one to hold the end of the measuring tape and the other to pull across the measurement distance.