

Stoves 101

Basic Stove Science for the
Non-scientist

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The Scientific Mindset

- The mindset of a scientist or engineer (as opposed to a normal person) is wrapped up in the question, “How much?”.
- Scientists/engineers are constantly asking this question, and then seeking to answer it.

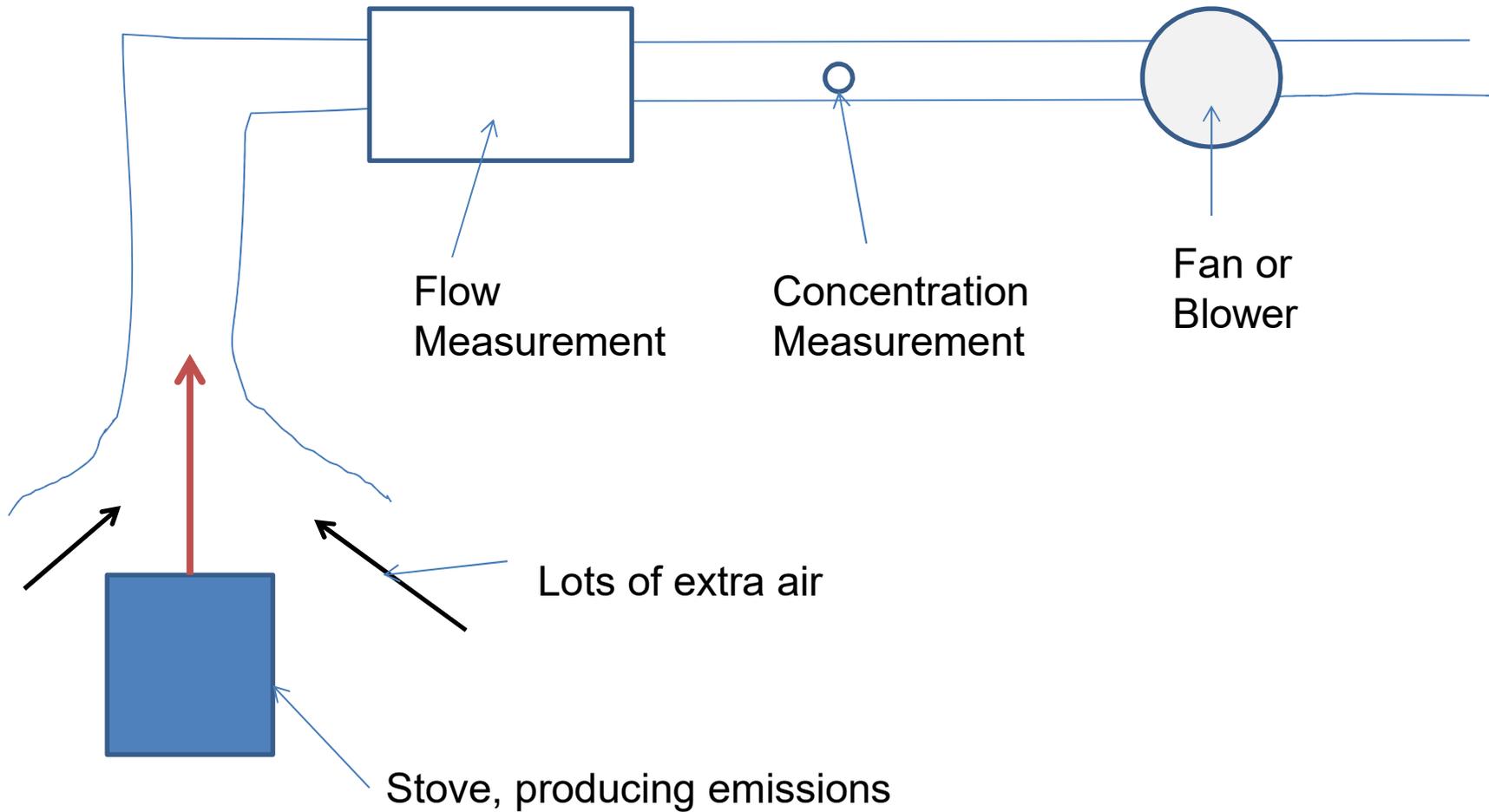
Efficiency Measurement

- **Thermal efficiency** is measured from the energy that goes into the pot, divided by the energy “contained” in the fuel that is burned.
- **Fuel use efficiency** is measured from the amount of fuel needed to do the job.
- **Cost efficiency** is the cost to do the job.
- Increasing the fuel use or cost efficiency is the end we seek, increasing the thermal efficiency is a means to this end.

Pollutants-What are we measuring?

- Two pollutants of general interest, others of more specialized interest.
- Carbon monoxide (**CO**) measured in parts per million (ppm).
- Particulate matter (**PM**) also known as smoke, measured in milligrams per cubic meter.
- Sometimes **PM2.5**, particulate matter smaller or equal to 2.5 microns in size, small enough to get into your lungs and cause trouble.
- A stove may not be producing visible smoke, but may still be producing significant particles.

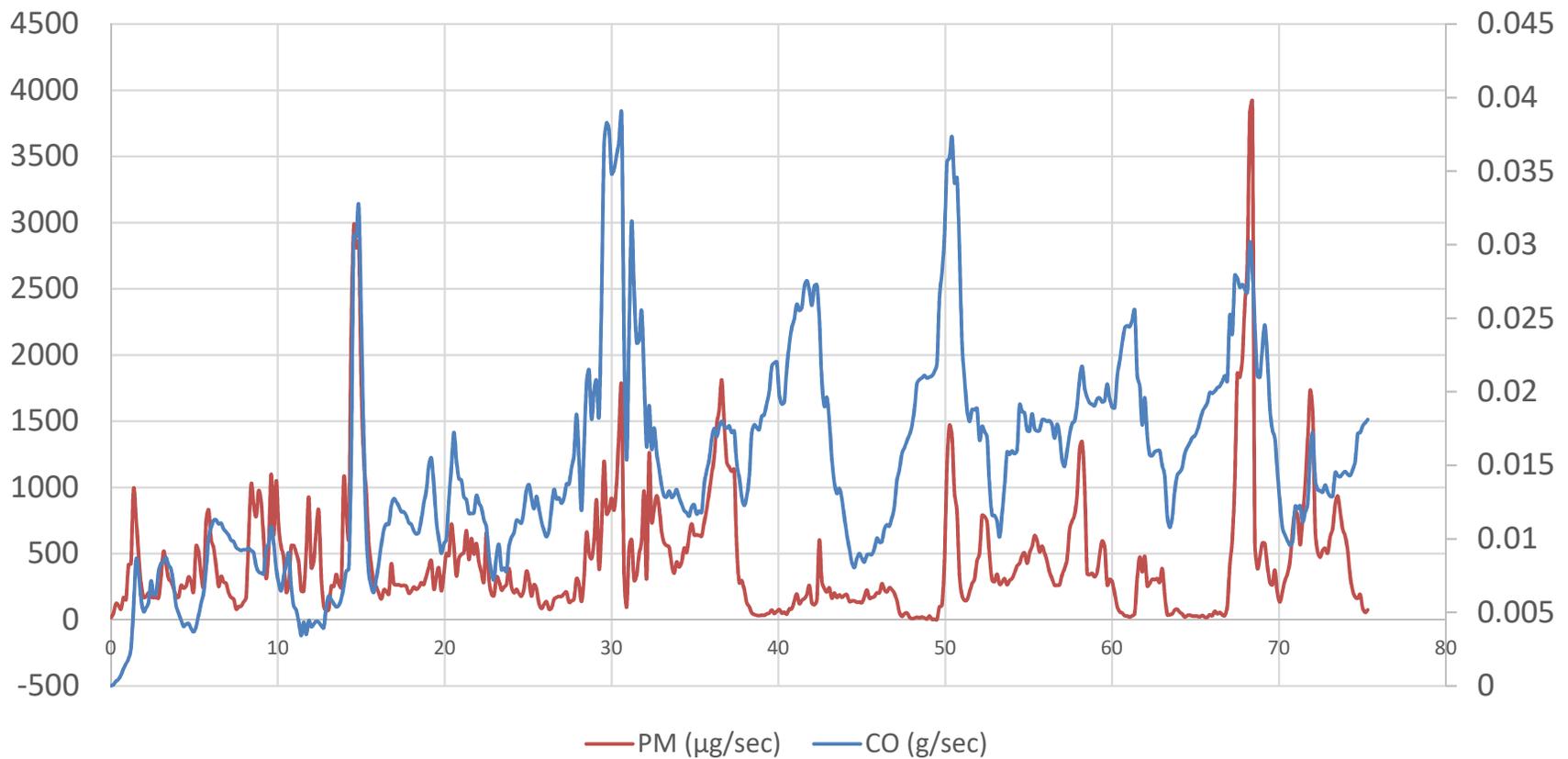
Standard Pollutant Measuring Method



Typical pollutant graph

(Pollutant production rate vs. Time)

12/ 19/17 Versatile Stove, no lid, dry wood



How to measure the pollutants

- Carbon monoxide, CO, is easy to measure with cheap instruments.
- Particulates are more difficult.
- You can measure approximately using light-based methods. Only approximate because different sizes of particles behave differently.
- More accurate methods are gravimetric methods, where you collect particles on a filter over a period of time, and weigh the filter before and after on a very accurate scale.

An example of light-based methods



How to measure pollutants, con'd

- Techniques are well worked out with Laboratory Emissions Measuring System (LEMS) and Portable Emissions Measuring System (PEMS).

Emissions vs. Exposure

- **Emissions** are what comes out of a stove, for example, 1.5 grams of particulates.
- **Exposure** is what people breathe, for example 100 parts per million (**ppm**) of carbon monoxide for 1 hour. Exposure is what relates to a person's health and there are guidelines for exposure.
- Exposure can be measured by instruments mounted on the wall, or attached to the subject in a backpack device.

Ways to Reduce Exposure without Reducing Emissions

- Chimney to get the emissions out of the house.
- Good ventilation or cook outdoors.
- Having the cook leave the kitchen when possible.
- Don't live in a city.
- High ceilings and/or short cooks

Exposure in the City (Nairobi)



Possible Newspaper Headline?

- PYGMY WOMEN SHOW GREATER RESISTANCE TO INDOOR AIR POLLUTION
- Scientists Baffled, Look for Genetic Clues

Indoor Air Pollution (IAP)

- Exposure and **Indoor Air Pollution** are sort of the same thing, but.....
- If the cook goes in and out of the kitchen, maybe not the same thing.
- Reduced exposure is the end we seek, reducing emissions is a means to that end.

Stove Safety

- Can a stove be tipped easily?
- Does it have hot surfaces that can burn people, especially children?
- Does it have sharp edges that can cut or scratch?
- Do sparks fly out of the fire?
- Are people (and their clothing) directly exposed to flames.
- All these things can be measured and minimized.

Measuring Pot Stability



Final Note on Science

- We can use a lot of science to study stoves, and this is valuable but
- Many factors that determine the success of a stove fall outside of what can be measured.