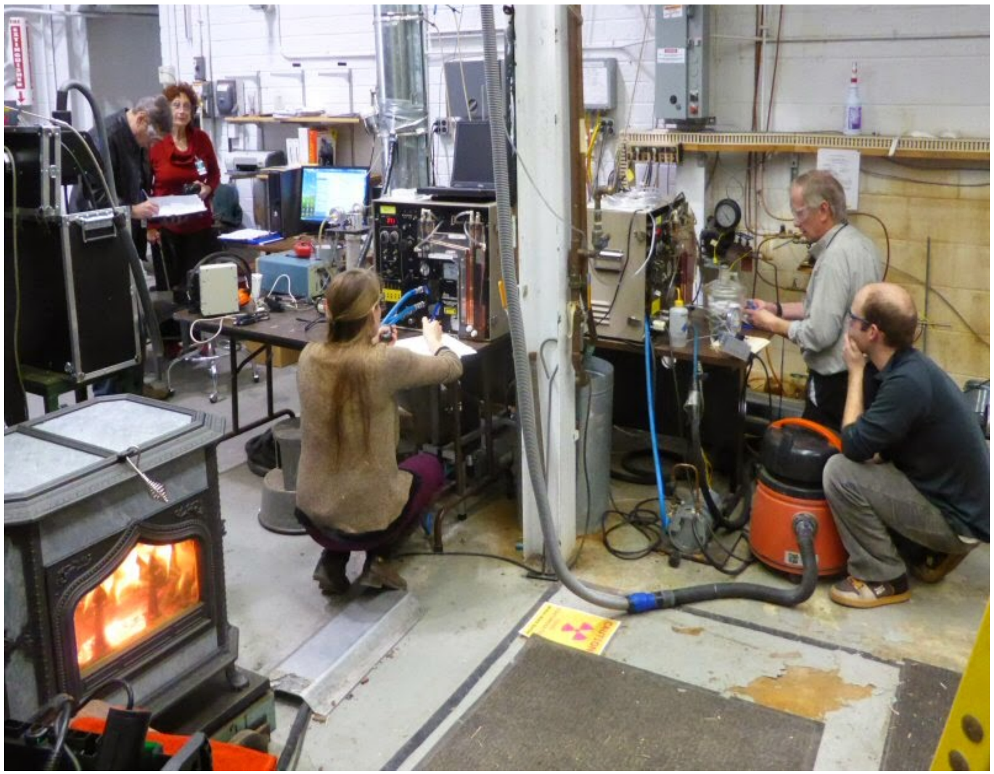
Biomass Heating and Cooking Stoves: Standards, Differences, Clean Burning Strategies



2015 WHO Biomass Cook Stove Emission Rate Targets and EPA Biomass Heating Stove Standards

2015 WHO PM 2.5 **Intermediate** Target for biomass ***cook stoves with chimney:***

7mg per minute

2015 WHO Emission Rate targets for biomass ***cook stoves with chimney:***

0.8mg per minute

Current EPA PM 2.5 Standard for biomass ***heating stoves with chimney*****:**

74 mg per minute

Proposed 2020 EPA PM 2.5 Standard for biomass ***heating stoves with chimney***:

33mg per minute

World Health Organization Targets

- **WHO Intermediate Emission Rate Targets**
- **Unvented stove** **Vented stove**
- PM 2.5 1.75 mg/min PM 2.5 7.15 mg/min
- CO 0.35 g/min CO 1.45 g/min
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- **WHO Emission Rate targets**
- **Unvented stove** **Vented stove**
- PM 2.5 0.23 mg/min PM 2.5 0.80 mg/min
- CO 0.16 g/min CO 0.59 g/min
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Why are the standards so different?

- Industry vs. Academia?
- Air is cleaner in USA?
- Chimneys work better in USA?
- Two very different communities

Heating and Cooking Stove Observations: Excess Air

- Heating stoves shut the door and severely limit the primary air.
- Cooking stoves without doors over the fuel entrance can’t limit the primary air as much.
- Ain cooking stoves a lot of air in the combustion zone cools the combustion zone so that temperatures are lower?

Time, Temperature, Turbulence

- Heating stoves may have higher temperatures and longer residence times.
- It seemed to me that the clean burning heating stoves at the Green Heat competition were gasifying initially with very limited primary air.
- Then introducing secondary air in separate chambers so the added air, high temperatures, and long residence times resulted in more complete combustion.

Burning Sticks Cleanly

- It seems to me, that stick burning cooking stoves with: 1.) Lower temperatures and 2.) Less residence time and 3.) An inability to gasify because there is too much primary air depend more on **metering** the fuel and more active **mixing** to burn cleanly.

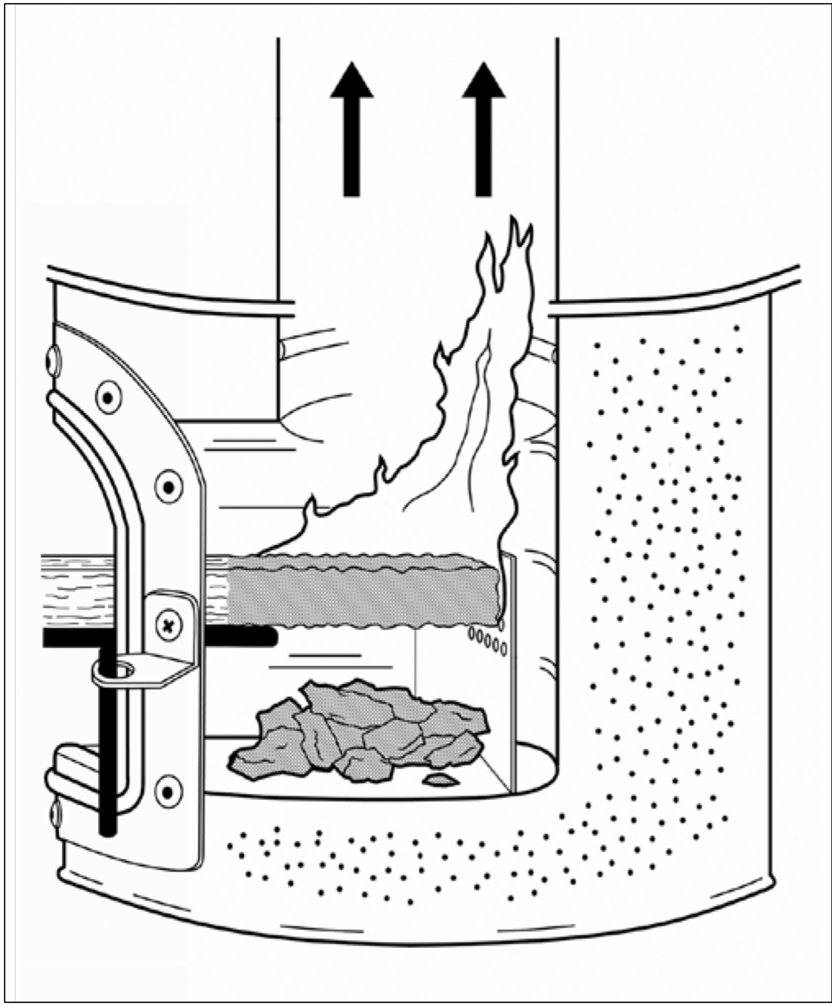
Both have Advantages?

- The closed box has the advantage of gasifying, higher temperatures, long residence times.

- The stick burning cook stove has the advantage of metered fuel so start up emissions are lowered?

Velocity/Draft

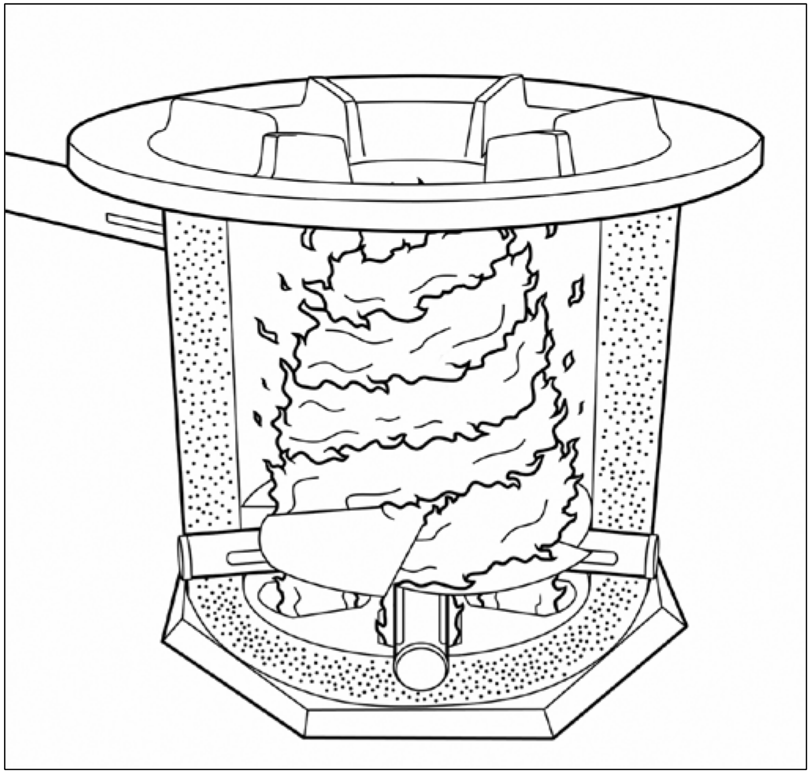
- The cooking stove needs high velocity of as-hot-as-possible gases to increase heat transfer to the pot.
- I guess that closed box heating stoves can have lower velocity?
- The cook stove needs lots of air into the combustion chamber because it cannot make very much charcoal. Too much charcoal clogs the combustion chamber.
- Heating stoves can make as much charcoal as wanted? Charcoal doesn't smoke.



Cook stoves depend more on mixing?

Forced draft air jets or natural draft static mixers are commonly used in low emission cooking stoves to achieve more mixing.

In clean combustion log burning heating stoves it does not seem to be as necessary because of hotter temperatures, longer residence times, and gasification?



Mixing it up?

- Forced draft mixing and metering are used in pellet burning heating stoves. (Also in a heating stove at the competition that burned the end of a pressed log).
- *Could better mixing help closed box heating stoves?*
- *If the fuel door can be closed, might the heating stove strategies help cooking stoves?*

Chimneys: 100% on heating stoves but generally not on cooking stoves?

Electrostatic precipitation