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Laboratory Testing of Rocket Stoves of Various Capacities
As Compared to the Three Stone Fire
April 3rd, 2007

In an effort to understand the relationship between stove capacity and fuel use and emissions the performance of three sizes of rocket stoves were compared.

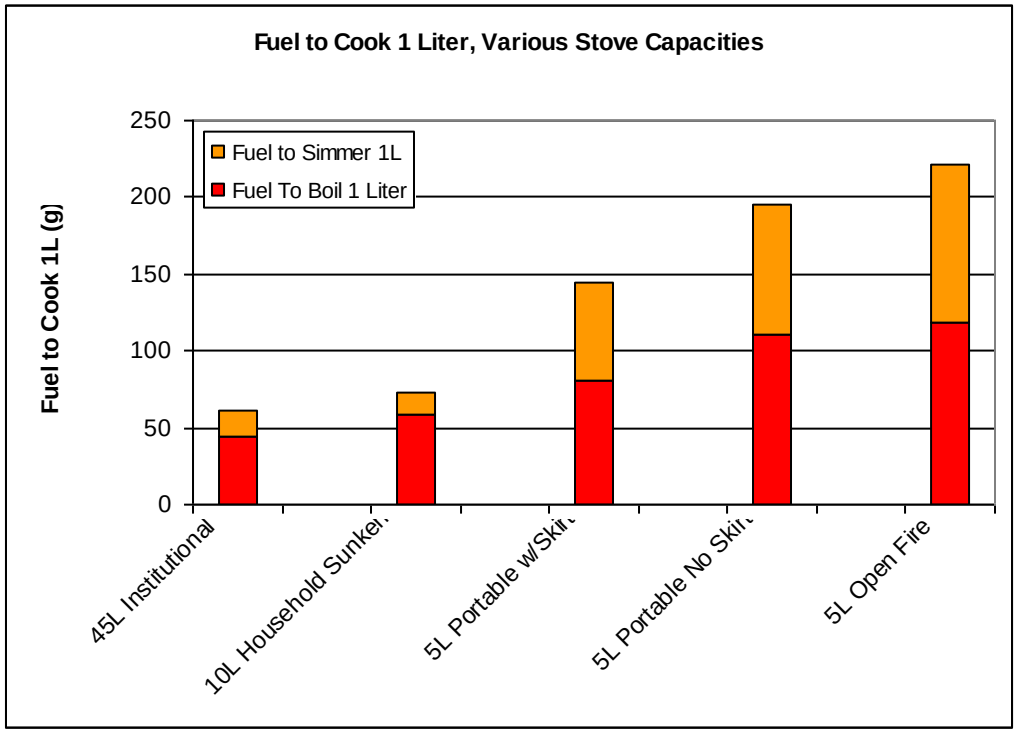
Three Sizes of Rocket Stoves Tested at the Lab

45 Liter Institutional Sunken Pot w/ Chimney

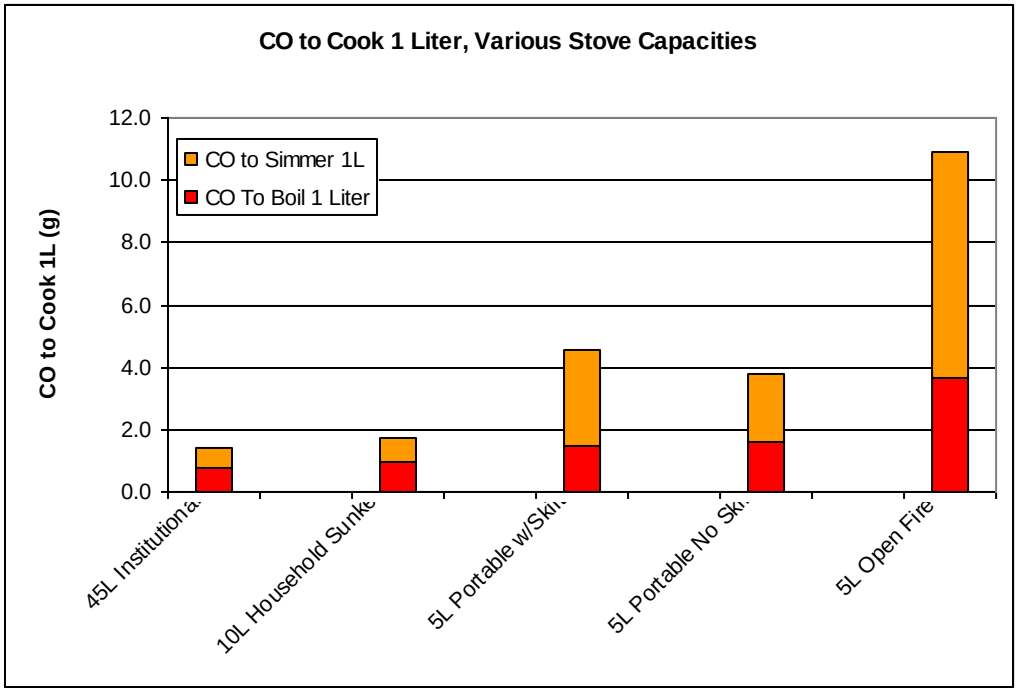
10 Liter Household Sunken Pot w/ Chimney

5 Liter Portable Household with and without Skirt

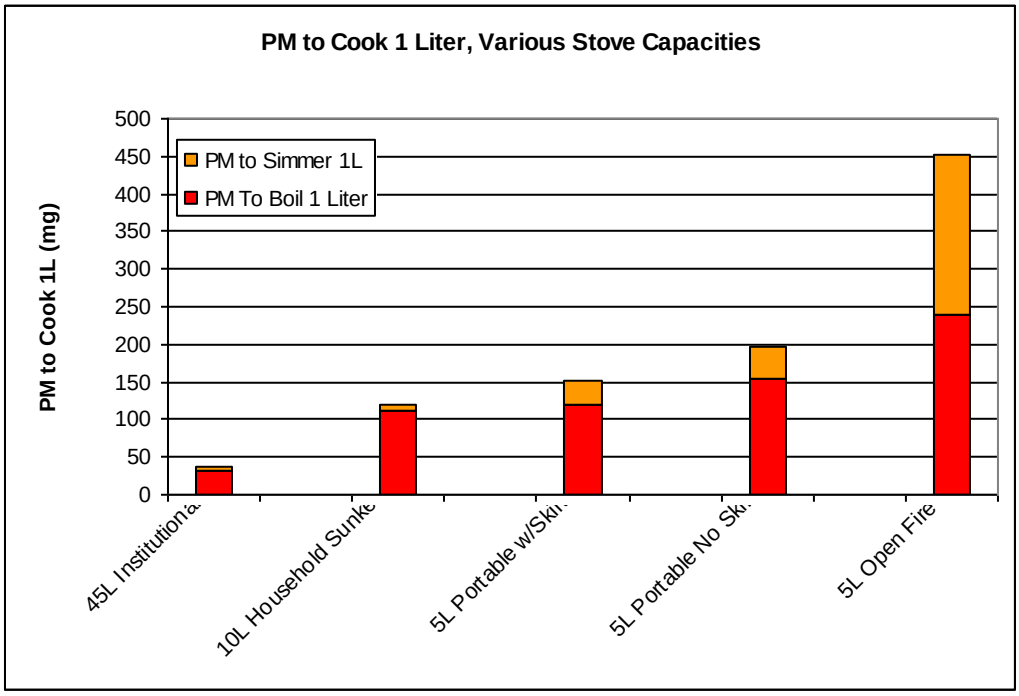
The stoves were tested with the 2003 UCB revised Water Boiling Test. Pots that were integral to the stoves were used without a lid. Kiln dried Douglas fir at approximately 10% moisture content was burned in all tests. Only one test was performed on the household stoves. Therefore, results are not statistically valid but should be useful for general comparison. The following graphs show results from three Rocket type stoves as compared to a carefully tended Three Stone Fire.



It is interesting to note in this preliminary study that the institutional and household stoves with sunken pots both had much lower fuel use compared to a portable Rocket with skirt. The large difference between the 45 liters and 10 liters of water in the two stoves did not seem to greatly influence fuel required per liter. The use of the sunken pot may be more important than the size difference of the pots/quantity of water. It is possible that the sunken pot stoves are more fuel efficient because hot flue gases also flow down the outside of the skirt, increasing temperatures close to the pots.

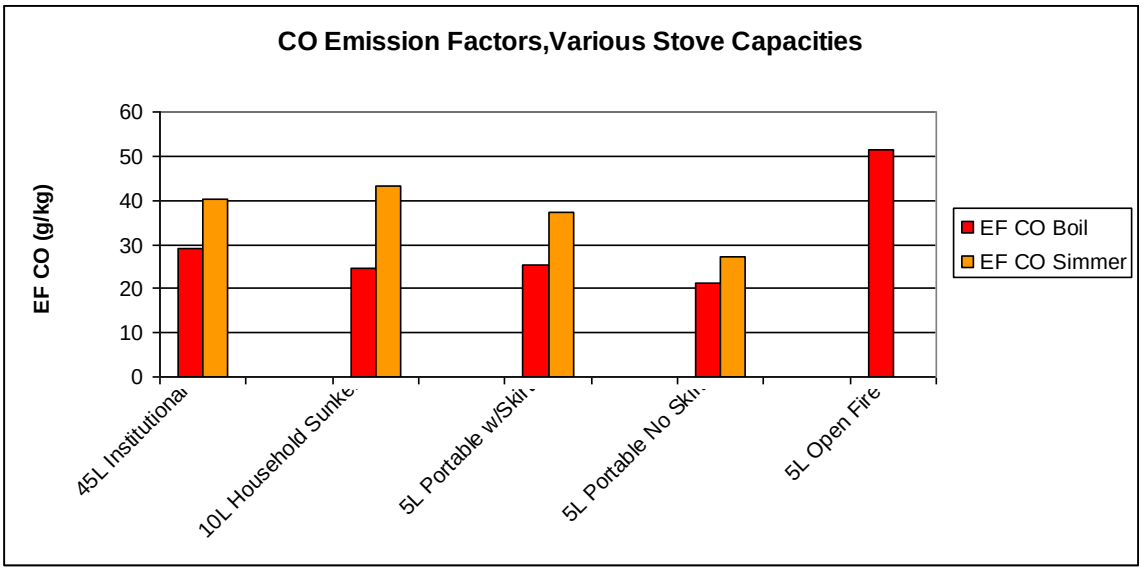


Carbon monoxide is also reduced in these sunken pot stoves. Because about half the fuel is used to boil and simmer per liter of water, about half the amount of CO is produced during the simulated cooking task by using a sunken pot.

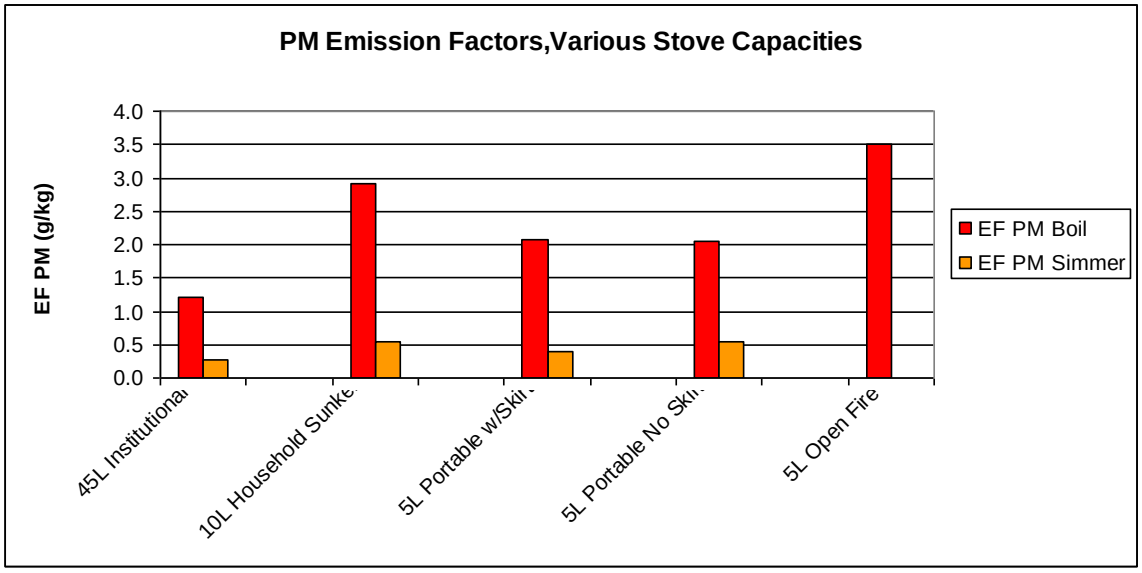


Particulate matter is usually more variable compared to CO. Small differences in the fire have large effects on the emission of PM. It has been previously noted that stoves with longer dwell time, like griddle stoves, two pot sunken stoves, and the institutional stove seem to be "scrubbing" the PM. PM is reduced in these kinds of stoves with longer runs between the combustion chamber and chimney. PM is again much lower in the larger institutional stove compared to the household stove.

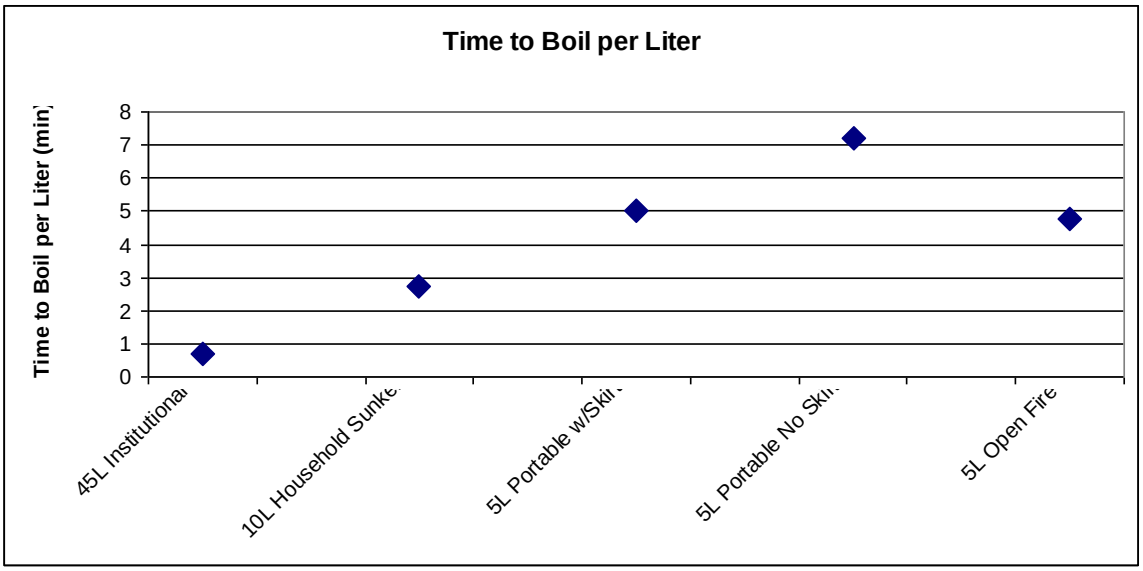
The hypotheses that longer runs in stoves reduce PM by 'scrubbing" (not by burn out in the combustion chamber) seems to be reinforced by the finding that the emission factor of CO is approximately equal in the four Rocket stoves. "Emission Factors" detail the amount of pollution made per mass of wood burned. All four Rocket-type stoves created about the same amount of CO from each kilo of fuel burned when boiling and simmering the water. Notice also that the rocket combustion chambers produced about half the CO of the open fire for each kilo of fuel burned.



On the other hand, PM was reduced by about half in the institutional stove as compared to the rocket stoves with shorter routes through the stove. This may be a result of "scrubbing".



The institutional stove took less than a minute to boil each liter of water. The household sunken stove was faster to boil compared to the Rocket with skirt. And the Rocket without skirt was much slower to boil per liter. As noted by other researchers, the Three Stone Fire can boil water fairly quickly. However, while doing so it creates higher emissions and uses more fuel. The open fire equals the Rocket with skirt and is faster to boil than the Rocket without a skirt. However, time to boil also depends on the firepower.



Even though the institutional and household stoves used about the same fuel to boil and simmer water, made about the same amount of CO, and had very similar CO emission factors, time to boil per liter was dramatically faster in the institutional stove. This is likely due to the fact that the institutional stove has a larger combustion chamber and thus a higher firepower, influencing how quickly the water is heated. When high firepower is combined with high heat transfer efficiency, time to boil is reduced significantly.

Turn down ratio is also better in the sunken pot stoves probably due to increased heat transfer efficiency. It takes less wood to maintain the water three degrees below full boil.