PCIA Webinar: Laboratory Test Results of Cook Stove Performance

January 12, 2012

Speakers

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Q1: Why did you do three tests for fuel use and three tests for emissions? Shouldn't fuel use and emissions be simultaneously measured?

A1: Fuel use was indeed simultaneously measured with emissions. The first three tests were fuel use only simply because those tests were done under the hood before we realized that the emissions equipment was not working properly. We just used the fuel use data and discarded the emissions data for these three tests, but then repeated the three tests again under the hood once the problem with the sensors was resolved.

Q2: Why did you decide to not test the panel and box solar cookers? Especially given no emission and no fuel cost. And do you plan to test them in the future?

A2: It was difficult to find a panel and box solar cooker that can boil 5 liters of water in a reasonable time. Therefore, we selected a parabolic solar cooker for this test series. However, solar cookers will be evaluated in the 3rd round of stove performance testing at the U.S. Environmental Protection Agency (USEPA) laboratory in 2012.

Q3: How many times was the solar cooker tested?

A3: The solar cooker was tested 3 times and we actually had data that told us what the solar radiation was at our location for the times of the test. We present some of the efficiency numbers based on how much solar energy made it into the pot versus how much solar energy was available to the solar cooker.

Q4: Are there any results testing the Ecocina stove we produce in Central America?

A4: The Ecocina is stove #19 in the journal article. We tried to avoid commercial names in the journal article, so the stove was described per its characteristics.

Q5: Is the efficiency usually better in the lab compared to the field?

A5: Nordica: In my experience there were a few stoves that we tested extensively in the lab and then also extensively with the controlled cooking test (CCT) in the field. We do not really look at the technical definition of efficiency, but we found that several of the stoves had similar fuel use reductions from traditional stoves in the lab and in the field. This was true for some of the stoves, but untrue for others.

Dean: I would say that efficiency is generally better in the lab. Sam Baldwin did a really good study of Water Boiling Test (WBT) and CCT results. If the stove is meant for boiling water, I would say generally, you are going to see fairly similar results. If the stove is used for another purpose in the field, it will be different. So in some cases WBT is predictive of what will happen in the field and in others it is not.

Nordica: It also depends on what you are trying predict. If you are saying it will take x amount of wood to make a pot of beans, that is absolutely not the purpose of the WBT, but if you are saying you saw a 40% savings in fuel use to do this task compared to the three stone fire, then this might be something that would translate to the field as far as comparing how switching from one type of stove to another will effect fuel use or emissions in the field. We have found some studies that studied the same stoves that we did in the lab that got the same results in the field, but this is not always the case.

An analogy would be the miles per gallon (mpg) rating for a car. If you accelerate the car rapidly at every stop light, you will not get close to the stated rating, but when you buy a car that gets 50mpg versus 20mgp, the rating will show you what type of fuel mileage you should generally expect to get.

Q6: We have performed 3-stone fire testing in the field and found wide deviations from the lab 3-stone fire. As the results are expressed relative to the 3-stone fire, do you suggest we retain a set of baselines for estimating potential fuel savings?

A6: As discussed and shown in the error bars of the graphs, the three-stone fire is expected to have wide deviation. So yes, it is a good idea to do many tests and compare stoves to the range seen from the three-stone fire.

Q7: Were there any Aprovecho results for charcoal-making stoves (TLUDs)?

A7: Stoves #24-26 in the journal article were TLUD-type stoves.

Q8: Where can we find more information about results from Kitchen Performance Tests (KPTs)?

A8: You can download proceedings from two previous PCIA webinars, "Impacts of Household Fuel Consumption for Biomass Stove Programs" and "Monitoring Fuel Use with the Kitchen Performance Test" at www.pciaonline/proceedings. These webinars share results from KPT studies in India, Nepal, Peru, Uganda and China.

Q9: The 2006 version of "Design principles for wood burning cook stoves" seems very Rocket Stove centric. Recent development around TLUD micro-gasifiers, provided by GIZ/GTZ and authored by Christa Roth, is not mentioned anywhere, nor are TLUDs. Is one to conclude that PCIA and Rocket Stoves are in some collaboration to promote only Rocket Stoves at the expense of other improved cookstove configuration, especially the TLUD/TCHAR configuration?

A9: The testing Aprovecho has conducted and presented here was done over a couple years' time period. This testing has helped lead to the development of many stoves, including, fan stoves, new TLUD and microgasifer stoves, and ultra clean cook stoves. When we refer people back to the Design Principles document (at www.pciaonline.org/resources), it is important to note that it was published in 2006 and there have been quite a few new developments since then.

Dean: The questioner was right that we need to come up with design principles for natural draft TLUD stoves and of course I have a preliminary list in my mind to help people make better TLUD stoves and this is a work in progress. TLUDs have extremely good mixing because the top of the fuel is all on fire and the gases and smoke made below the fire have to pass through the flame bringing really good combustion and excellent mixing. Charcoal stoves now in the last two years have made tremendous strides where you can burn up a lot of the carbon monoxide (CO) by adding jets of air and encouraging flame, again a better mixing process. The fan stoves, where you not only have batch loaded stoves now, but you have side feed fan stoves where you can use sticks of wood like you normally would and provide improved mixing above the fire. There are even attempts now for natural draft solutions using sticks concentrating on the improved mixing to make them cleaner. We live in a brave new world and I am happy to be there.

Q10: The WBT seems designed around the Rocket Stove option, and is far less appropriate for TLUD micro-gasifiers. Why is the bias built into the WBT test?

A10: As mentioned in Q9, gasifier stoves are a fairly new development, and the WBT was designed beginning in the early 1980's (when even rocket stoves were not yet developed). Part of the working group on updating the WBT is trying to address this issue. It is not exactly biased; it is just difficult to compute fuel use properly since it is challenging to separate the fresh wood from the char when the water reaches a boil.

Q11: Why do stoves with a chimney look like they are not efficient in terms of fuel consumption?

A11: Test results show that efficiency is directly related to how much of the pot is directly exposed to the flame. Some of the chimney stoves have a solid griddle with no hole for the pot because they are designed for regions that primarily use the griddle for frying food instead of boiling food. If the heat from the fire has to pass through a thick piece of metal before it gets to the bottom of the pot, this is going to take away a lot of the heat transfer into the pot.

Looking at the left side of the graph on slide 40, where you have a really big pot and are getting much better heat transfer, this 60 liter stove was probably the most fuel efficient stove in the test. As an aside, because you are using so little fuel, per product made per liter of water boiled and simmered, even using a normal rocket combustion chamber, you are meeting extremely clean goals for CO and PM. Optimizing heat transfer can result in so little fuel use that even if you do not burn it super clean, per product of food made, you are in the very clean category.

Q12: Did you rate the (TLUD) gasifier performance including or excluding the produced charcoal?

A12: The Aprovecho test results for TLUDs did not include the char produced. You can find more up-to-date information on the very good performance of TLUDs in the webinar proceedings of "EPA Lab Test Results for Household Cook Stoves" available at www.pciaonline.org/proceedings.

Q13: How, all in all, do you rate gasification stoves (TLUD), most of all in respect to the efficiency?

A13: It really depends on the design of the stove. The TLUD idea itself is the combustion chamber – it is how you transfer the heat produced into the pot that dictates "efficiency." So any stove should be carefully designed to optimize heat transfer into the pot as well as burn the fuel cleanly.

Q14: Could you explain how you monitored the moisture content?

A14: We used the oven drying method which is described in detail in the WBT protocol (available at www.pciaonline.org/testing). For this method, you take a random sample of about 300-400 grams of your fuel and put it in an oven at just below boiling temperature for 24-48 hours depending on how long it takes for the mass to stop dropping. You can easily calculate the moisture content based on the original weight and the weight of the sample once it is completely dry. Aprovecho has found this to be the easiest and most reliable method of calculating fuel moisture.

Q15: In the book it says that for the alcohol stove a lid was used in to bring to boil. Is that reflected in the comparative tables?

A15: The original test of the Clean Cook stove would not boil the 5 liters of water without the lid. We told the designers and they took a look and redesigned the pot supports of the stove and had us retest and it would boil the 5 liters without a lid. The data presented is without a lid.

Q16: Would you learn more if you did the WBT both with and without pot lids?

A16: We know that using a lid reduces heat loss from the pot. The authors of the WBT over the last couple of decades agreed that not using a lid reduces scatter in the data. So, we could learn how much more efficient a stove is when a lid is used, but it would be more difficult to track differences between stoves due to scatter.

Q17: Any discussion possible on the use of skirts for the pots in WBT? Any used in any tests?

A17: Generally if a stove came with a pot skirt, we would use it, if it didn't, we would not. The skirt establishes the channel gap and reduces the boundary layer, exposing more of the flue gases to more of the pot. Yes, it definitely reduces fuel use as it makes it faster to boil, about 25% improvement just from the use of a pot skirt. The metal VITA stove and the mud sawdust stove have built-in pot skirts. You can build a stove that is a skirt and it is very successful in reducing fuel use.

Also, in the graph from the journal article, there are 3-4 stoves with and without a skirt that were tested and that data is right next to each other. By looking at the labels on the axis, you can see how the skirt changed the fuel use or the emissions results.

Q18: In your research you found that chimneys obtained a drastic reduction in indoor emissions but often times increased fuel usage. Other studies have documented that adoption of improved stoves is influenced mainly by benefits of fuel reduction. Therefore, how do you see chimneys gaining widespread adoption?

A18: A well-designed chimney stove with good heat transfer to the pot is the Cadillac of stoves, in my opinion, and it is what my mom uses at home in Minnesota. The cook can have multiple pots going, clean air, and the stove can be a nice, attractive appliance in her kitchen. I have visited many homes in Central and South America that went from soot-covered walls with three-stone fires to absolutely lovely efficient chimney stoves and the families were so happy. They decorated the stoves, painted the kitchen, and it was a whole different scene. Well-designed chimney stoves do not necessarily use more fuel in-field than they previously had, as the stoves can multitask,. So yes, I have seen, and hope to see, chimneys gaining widespread adoption.

Q19: Do you have data on the size of the average family and the volume of food cooked at one time?

A19: No, that varies between homes and regions. KPT studies done by Berkeley Air Monitoring Group would have more region-specific information on this.

Q20: Were any tests ever performed with the Kelly kettle? (Central hole/chimney in the pot)

A20: No, we did not test this stove and are not familiar with the name.

Q21: Did the safety test include tipping the stove over to see what happens? Kerosene wick stoves are extremely dangerous in this regard yet they score quite well for safety which is odd.

A21: Please see page 121 of "Test Results of Cook Stove Performance" (www.pciaonline.org/resources) for details on the safety evaluation. It covers 10 safety issues, including tipping. The kerosene stove did lose points for being easily tipped, but scored fairly well on the other nine metrics.

Q22: What quality controls are applied to the pollutant instruments?

A22: We had an USEPA-approved quality assurance plan in place, where the instruments were calibrated per industry standards on a regular basis.

Q23: What are the specific safety standards that are measured for each stove?

A23: Please see pages 121 - 126 of the new PCIA publication "Test Results of Cook Stove Performance."

Q24: It appears that the safety rating of the 3-stone fire (21) is better the solar cooker (32). Why? What kind of solar cooker? What criteria were used? Is evidence of solar cooker danger available?

A24: Actually, a higher score indicates higher safety, so the solar cooker is considerably safer than the three-stone fire, even though the focal point in a parabolic solar cooker can start fires spontaneously.

Q25: How can I get the portable testing equipment, and how much does it cost?

A25: You can contact Aprovecho Research Center. The basic "laboratory in a suitcase" (the PEMS) costs $10,000, and there are add-on instruments available. There is also an indoor air pollution (IAP) meter which logs carbon monoxide (CO) and particulate matter (PM) concentrations in a kitchen for short tests or even up to one month for under $3,000.

Q26: How can we provide Testing Providers in developing countries and what are the average costs of tests?

A26: There is currently an effort to support Regional Testing Centers. You can find a list of regional test centers in this presentation and online at www.PCIAonline.org/testing. Costs of tests vary between centers. Aprovecho usually charges about $2,000 for a basic WBT test series.

Q27: Do you also test stoves after they have been used for a long time in the field?

A27: We have not, but we could.

Q28: What has been your experience with chimney maintenance over time?

A28: If cooks are properly trained in the importance of chimney maintenance, or there are follow-up visits from stove distributors, it works well. But we have also seen clogged chimneys and abandoned stoves, so it completely depends on the situation.

Q29: I am surprised not to see the Vesto stove in the test group. Recent work testing with multiple fuels in Indonesia (three fuels) has shown it to be both cleaner and more thermally efficient than the Champion natural draft TLUD gasifier and two other devices. Will this be included in future testing at Aprovecho or the PCIA?

A29: The Vesto stove has been selected to be evaluated in the 3rd round of stove performance testing at the EPA laboratory to begin in February 2012.

Q30: We use the WBT to calculate ER and therefore need to do the test out in the field at people's home. The test therefore needs to be very user-friendly. We see the main challenge in testing the wood moisture on site and would be interested if you can provide guidance on the wood moisture measurements. Did you bring you own wood with you?

A30: All of our WBTs were done in our laboratory with the same wood supply used for each test. If you are testing in homes with the WBT (which is unusual), you probably want to provide the same wood to each home, and measure a random sample of that wood. As long as you take your wet wood weight at the relative time and location of the test, you can bring the wood anywhere to dry and reweigh it. There are some digital moisture meters that work suitably well. The CCT and KPT are designed for in field testing. For more information on these tests, visit www.pciaonline.org/testing.