SWBT Testing Report for Grate, Rocks bed with Metal grate and Conical pot skirt

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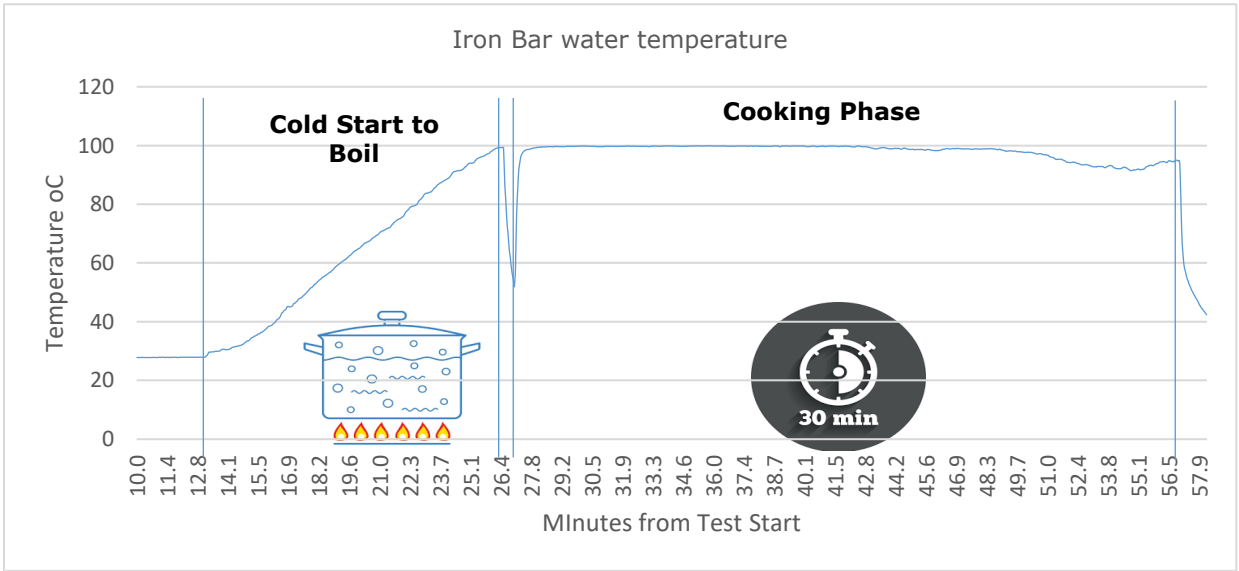
Background

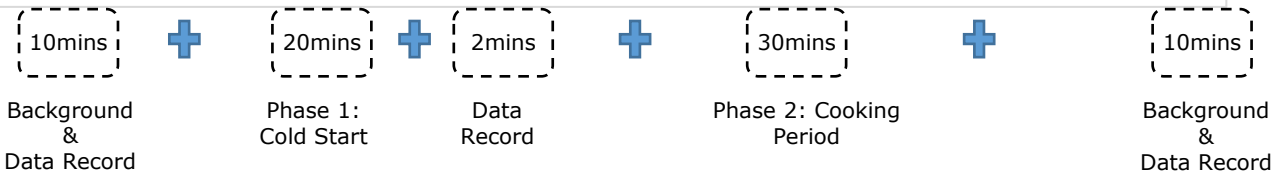
The grate and rock stone cooking innovation are simple and cheap solutions that may proof suitable and effective to introduce in areas where the three stone fire is the norm. This lab test at the University of Science and Technology in Hanoi, and conducted by SNV Netherlands Development Organisation, aims to triangulate the findings of different trails and field test conducted by Sun24 in countries such as India, Kenya and Uganda.
According to the qualitative user survey with 99 women in previous test shows that with this small modification, the rock bed stove emits less smoke and higher thermal efficiency compared to the 3-stones stove without rocks
In order to quantify the fuel saving and emission reduction, SNV Vietnam conducted the lab test to qualify the difference in the efficiency, PM and CO emission between the Iron bar stove (which is similar to the 3 stones stove in term of efficiency) and the variation setting of rocks bed and grate.

The test was done applying the Simplified Water Boiling Test (SWBT) under which results are presented in comparison to each other.

Simplified Water Boiling Test

The Simplified Water Boiling Test (SWBT) is a two-phased test that replicates real time cooking events as recorded in Vietnam, Cambodia and Laos, as related to our experienced in all 25+ countries where SNV undertakes cookstoves interventions.





Phase 1: Cold Start to Boil

In this phase we record the time to boil, the emissions and fuel efficiency, to bring of 3 liters of water to local boil from room temperature.

Phase 2: Cooking Period

During the cooking period the water volume is kept at temperature range of 5ºC below local boiling temperature for a period of 30mins; emissions and fuel use are recorded.

Test arrangement

The iron bar rocks bed with metal grate and conical pot skirt were tested as below:

Arrangement for IB only:

Arrangement for IB + grate:

Arrangement for IB + rocks bed:

Arrangement for rocks bed IB + metal grate:

Arrangement for rocks bed IB + conical pot skirt:




SWBT Performance Review

In the below tables and graphs below, the stoves performance parameters are presented in relation to the performance of Iron bar only and the LPG stove, the least and most advanced options in the stove stack of rural Vietnam.

IB with a grate is superiour to the stone bed stove, but both signifantly save energy and emissions compared to iron bar.

Performance Metric (Average from 3 tests)	Unit	Iron bar (IB)	LPG	IB+Grate (A)	IB+Stones (B)	IB+rocks bed+metal grate (C)	IB+rocks bed+conical pot skirt (D)
High Power Thermal Eff.	%	23%	64%	35%	28%	36%	35%
Wood fuel equiv. consumed	g	877	227	466	606	472	508

Comparison

Difference to IB only	IB+Grate	IB+Stones	IB+rocks bed+metal grate	IB+rocks bed+conical pot skirt
Total time taken (inclusive of lighting period)	26.0%	12.6%	29.0%	33.4%
Wood fuel equiv. consumed	-46.9%	-30.9%	-46.2%	-42.1%
Wood fuel equiv. cons./min	-57.9%	-38.2%	-58.4%	-56.7%
High Power Thermal Efficiency	49.3%	18.8%	52.0%	48.4%

Observation

- With all rocks bed setting variation (A, B, C, D), the efficiency and fuel consumption are substantially higher compare to iron bar only (IB). This is explained by superior air circulation with the grate/stones, more concentrated fire directed to the bottom of the pot that improves heat transfer and less heat loss to the ground.
- Fuel consumption and efficiency for Grate options (A and C) reduce more than rocks bed only option (B) since the grate allows for better air mixture and optimal combustion. The grate holes creates a better draft that is directed the fire.
- The performance of ceramic grate is quite similar to the metal grate with 2 layers of rocks bed. However, as observed during the previous KPT, the ceramic grate is very easy to be broken so if disseminating the cooking innovation, the metal grate with rocks bed might be a more durable solution.
- When putting the conical pot skirt around the pot (D) for rocks bed only option, the efficiency and fuel consumption was improved and closer to the Grate options (A and C). With this setting, part of the hot air instead of radiating outside, it will concentrated by the conical pot skirt and heating the pot. Therefore the heat was better optimized. Looking at the smoke went straight up around the pot in the video Conical pot skirt.mp4 could illustrate the above conclusion.