

TLUD-OVEN

LOW MASS OVEN POWERED BY "TLUD" STOVES

Marc AYATS PLANA*

(*) Estremera Nova, Bunyola, Illes Balears, Spain

www.cuinessolars.jimdo.com

marquitusus@hotmail.com

ABSTRACT

Tested the operation of a low thermal mass oven powered by TLUD stoves. It has reached a temperature of 200°C for 2h30 minutes using a total of 3.38 kg of pellets as fuel. Although emissions hasn't been measured, no smoke has been seen in the overall process, assuming a pretty clean combustion. 2 loaves of bread has been baked with 1 Kg total weight. Has been concluded that, despite more research is needed, the TLUD-Oven has a great potential to achieve very energy efficient baking processes.

Key words: TLUD-Oven, oven, gasifier, TLUD, pellets, bread, efficiency, appropriate technology

INTRODUCTION

There are two recent advances in efficient stoves in which I have been working in: the improved low thermal mass ovens and the TLUD (top-lit up-draft) stoves. The idea came naturally: what would be the result of combining the two technologies? Could we make the very efficient and clean burning TLUD stoves to run an oven like this?

METHODOLOGY

First I had to build a gasifier stove, TLUD type, that had enough power to run the oven. This stove I made is very similar to the TLUD "Champion" type, developed by Paul S. Anderson ("[Dr. TLUD](#)"). Although, I have introduced two changes:

- a) **Increased primary air draft**, which can apport enough oxygen to burn the coal generated during the gasification process and continue giving heat to the oven. Now the primary air enters around the lower perimeter of the reactor, instead of having a single inlet tube like in the original model.
- b) **Increased the length of the riser**, which also sustains the diffuser. This extra extension allows the complete combustion of gases gasification to completely remove the visible smoke in the oven.

Due to previous experiences with the same oven and similar TLUD stoves, I decided that the stove should have the following characteristics:



Figure 1. TLUD parts and assembled



Figure 2. TLUD Reactor. Diameter: 20cm. Total length: 30cm. Fuel Height: 20cm



Figure 3. TLUD Outskirt. Diameter: 22cm. Diameter central hole: 10cm. Total length: 25cm



Figure 4. TLUD Riser and diffuser. Diameter: 12 cm. Total length: 30cm. Diffuser: granite piece 2cm thick and 15cm diameter



Figure 5. Fuel load. Fuel type: pellets



Figure 6. Fuel load.Quantity: 3,38 Kg

Low thermal mass oven: I did it following the rocket oven developed by Jon Anderson and Florence in 2011 (http://www.rechoroket.com/Links_to_albums.html). Here you can see the overall picture of the oven and the process of construction (www.cuinessolars.jimdo.com/forns/)



Figure 7. TLUD Oven assembled

Fire was started at the top of the column of pellets with lighter fluid.

RESULTS AND DISCUSSION

Here you can see the complete temperature profile. Besides the 20cm reactor TLUD, I put also a side by side comparison with a smaller TLUD, with 12,5cm reactor.

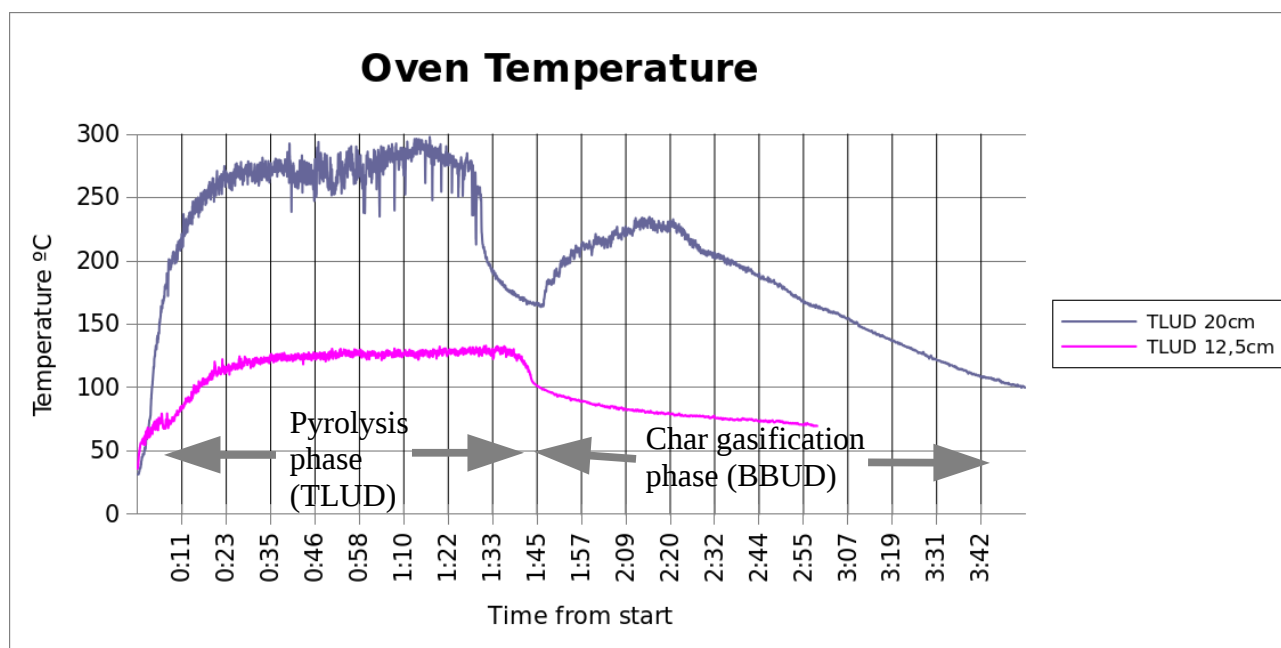


Figure 8. Oven temperatures profiles

Note: the temperatures refers to the inside side of the wall oven, half way between the baking surface and the top hole. Note2: the temperatures were taken by a temperature datalogger and a type K probe.



Figure 9. Flat-type bread just out of the oven

Notes about 20cm TLUD test

- 8 minutes to get 200 ° C
- 17 minutes to get 250 ° C
- 1h17minutes to peak at maximum temperature: 298°C
- In 1h30m from start the flames extinguished and began the char gasification
- In 2h30min from start the temperature dropped definitely below 200 ° C
- It has been spent a total of 3.38 kg of fuel. The price of 15kg of pellets is 6 € approx. Therefore, the price of this oven batch was 1.35 €.
- On average, consumption was 22.5 g of fuel per minute.
- No visible smoke appeared at any moment of the process.
- The outside temperature was 32 ° C
- Just for testing, 2 loaves of bread were cooked with a total weight of about 1 kg, occupying a total of about 35 minutes. In total, I could have baked around 5kg of bread in the 2.5 hours of operation.
- The bread was cooked optimally. Although, maybe the temperature was a little higher than the desired one in most bread recipes (in general, we can say that bread needs a temperature of 250°C the first 5-10 minutes but then lows to 180-200°C for the rest of the baking process)
- A lot of heat went out of the upper hole of the oven. Maybe this tends to cool the oven.

Comparison between different TLUD sizes

- The power of the TLUD is proportional to the area of the reactor. So, in theory, the 20cm diameter TLUD (314cm²) should give us 256% more power than the 12,5cm diameter one (122,7cm²).
- The experimental results are more or less confirming the theory, as the average temperature and the maximum temperature are about 220% of that of the 12,5cm one.

You can see the experimental results in the next table:

| Parameter | Ud. | TLUD 12,5cm | TLUD 20cm |
|---------------------|-----------------|-------------|-----------|
| Radius | cm | 6,25 | 10 |
| Radius ² | cm ² | 39,06 | 100 |
| Area | cm ² | 122,7 | 314,2 |
| | % | 100,0% | 256,0% |
| Average temperature | °C | 125 | 275 |
| | % | 100,0% | 220,0% |
| Maximum temperature | °C | 133,1 | 298 |
| | % | 100,0% | 223,9% |

Table 1. Experimental data of two TLUD models

CONCLUSION

Despite more research is needed, it can be seen that the combination of the low thermal mass ovens and the TLUD stoves, has a great potential to achieve very energy efficient and clean baking processes.

FUTURE RESEARCHES

- Test the performance with other fuels less processed (almond shells, pine chips, ...) in order to reduce the cost
- Try to partially cover the upper hole of the oven, limiting the draft but also the leaving heat.
- Try to find the exact diameter of the TLUD stove that can maintain an average constant temperature of around 200°C, suitable for baking most bread types and recipes.
- Test the combination of a high thermal mass oven with a TLUD.
- Measure the emissions of a baking process in the TLUD-Oven

REFERENCES

http://www.rechoroket.com/Links_to_albums.html
<http://www.drtlud.com/>
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