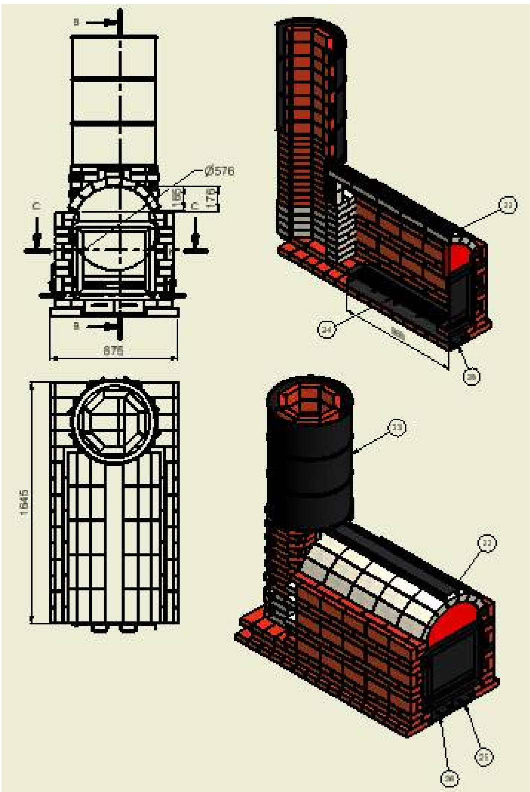
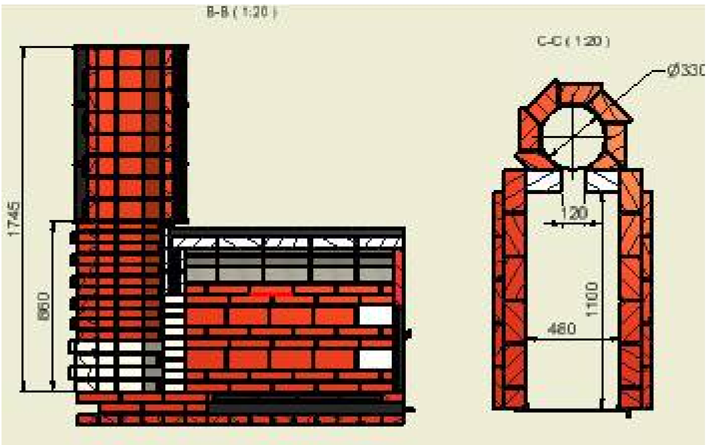
Characteristics
BBR13. Wood plank drier.
Site: Trevelin, province of Chubut, Argentina. 43°07'20,66"S; 71°33'41,57"O
Design: Hacono: Pablo Kulbaba + Ramiro Walti. Based on BBR design and test work by Peter van den Berg (www.batchrocket.eu)
Build: Collective build with 15 students within a 3 day workshop. There was a pre workshop day in which happened some 90% of the brick cuts. There were also several days before the workshop dedicated to gathering materials and preparing the mud for mortar.
Client: INTA (National Agricultural Technology Institute of Argentina), Esquel Agency. http://inta.gob.ar/noticias/taller-y-construccion-de-estufas-rocket

Purpose: The stove is built in an experimental facility where structural wood products are milled from fresh pine rolls. The milled products need to have their quality improved, and that involves drying. The current drier mainly uses sun gain to heat air which will be used to heat wood in a drying chamber (DC) absorbing its excess humidity. This is done forcing a current of air through a solar air heater made of plastic and wood structure. To hybridize the process, there was the need for a woodburning stove with a heat exchanger. The BBR13 was experimentally selected, based on previous experiences on BBR10 (Las Amalias/San Pedro BBR10 stove, October 2016, Hacono)

Schematics:
These are the planned dimensions for the combustion chamber.



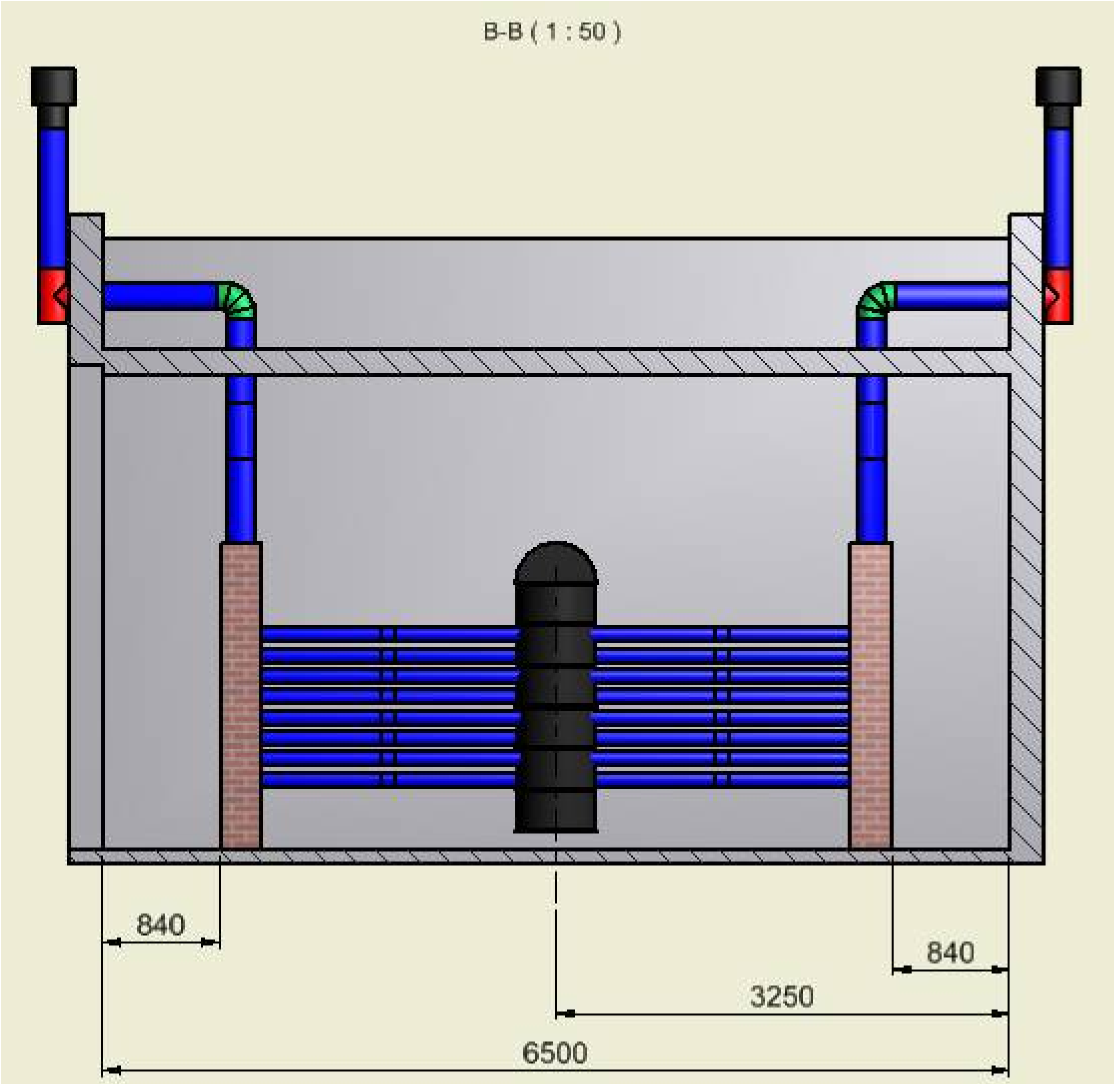
Picture 1



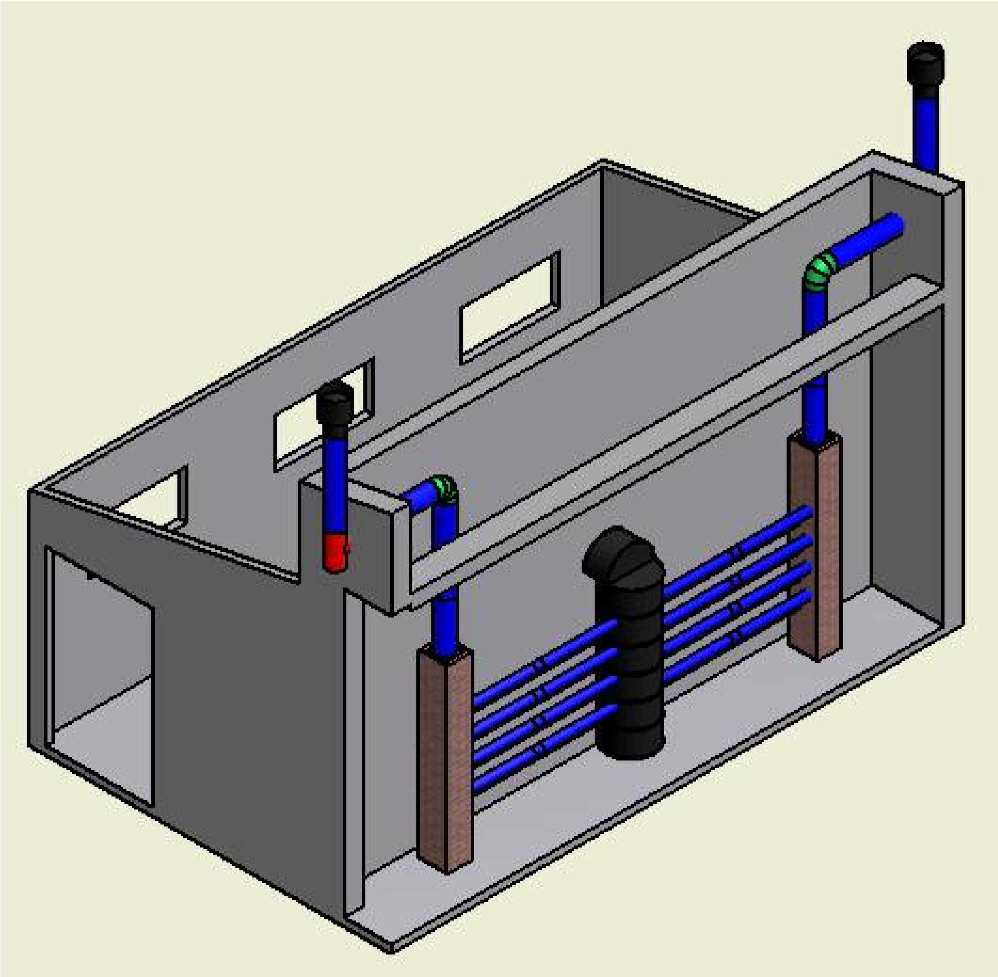
Picture 2

Schematics of the heat transfer system.

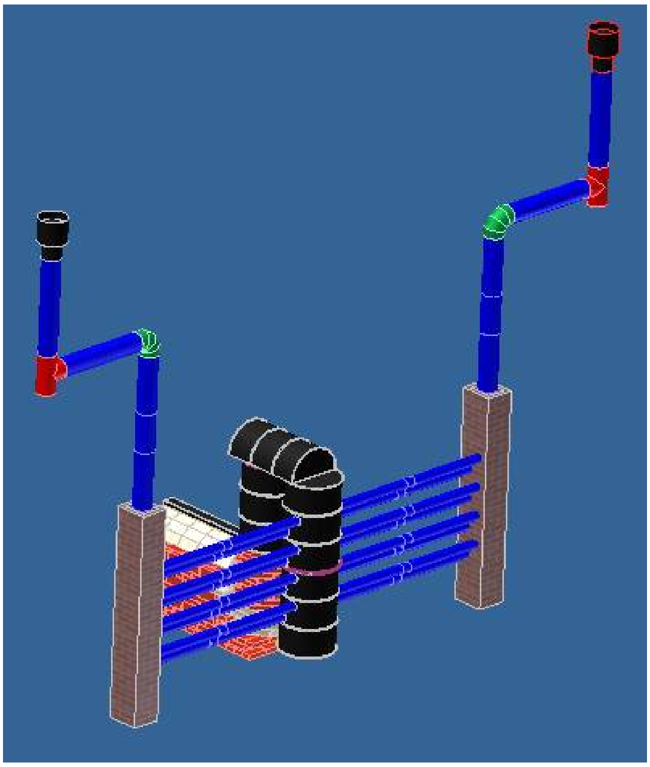
Criteria for the amount of tubes: 1,5 System CSA
Criteria for tubes length: fitting the whole system in the DC.
The system mainly uses radiant heat and convection as transfer mechanisms. The more commonly available pipe in the building area are 4″ galvanized steel pipes of 1 meter length. That's what we used.
Description of the heating system: A BBR13 combustion chamber built with a mixture of refractory bricks and common red bricks (1 refractory brick costs the same as 12 to 14 red bricks, economy criteria) converts wood into clean heat + CO_2 + water vapor.
The hot gases are conducted through an 11,25B high heat riser isolated with straw, clay and sand mixture (the straw burns away leaving empty spaces behind). Again, economy and available materials in the area are the main criteria. The usual material in this application is pearlite or vermiculite.
The gases don't descend concentrically to the heat riser as usual, but they descend through a 3 200l barrel tower, which delivers heat, and acts as a distributor for the symmetrical 8 tubes per side arrangement.
8 pipes per side of the distributor, 4″ diameter amount this CSA= 2 x 8 x 5cm x 5cm x pi = 1257 cm²
The BBR13 CSA is 856 cm².
The gases are then collected in two twin towers made of red brick, set in clay sand mortar. As the building did not exist at the moment of the workshop, the flue pipes were not installed. Only the chimney caps.



Picture 3



Picture 4



Picture 5

Day 0. Brick cuts in pre-workshop day (18 man hours with two 4,5" angle grinders. The available equipment in place)

Picture 6. Cut bricks in day 0. Left: Heat riser early courses. Center: Vault pieces. Right: Heat riser isolated courses

Picture 7: Cut bricks for P channel port lintel.

Day 1.

Picture 8: End of day 1 build. Firebox and early courses of heat riser. P channel horizontal metal piece in place. We used a portion of a 200l drum as a cimbra (temporary support for the vault)

Day 2. Early start.

Picture 9: Firebox coated and heat riser at planned height (1,80m; 7,5B). Ramiro facing down. On the right, one of the twin towers rising.

End of day 2 build. We started a fire to get to know more of the BBR13 behavior, and we got some lucky findings from it. Fire started 17:50.

Picture 10: 18:07 pm. Flames start to get through the port.

Picture 11: 18:55 pm. The cone of glow is coming up

Picture 12: 18:59 pm. Another shot of the cone.

Picture 13: 19:16 pm. The cone gave way to flames

Picture 14: 19:20 pm. Flames coexist with the cone

Picture 15

Picture 16: We realize we can contain these flames adding more height of heat riser

Picture 17: The equivalent height of a 200l drum is added with bricks and the flames keep showing up. We agreed to add this height to the riser in the next day to preserve the metal parts from the flames

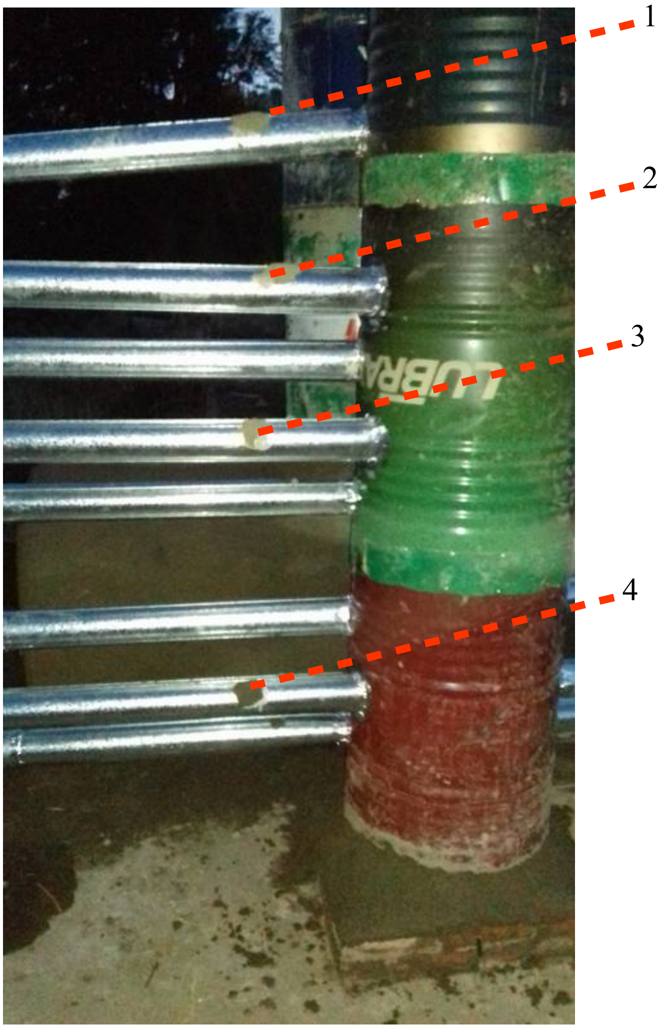
Picture 18: 19:48 pm. One of the twin ash drawers. Part of the provisions to increase the burn rate is making space for the new wood. There was no floor isolation for this firebox, as the ash drawer with its cargo of ash (charcoal in this picture) provides the isolation for the wood burning above it. This metal drawer 2mm thick will have to be thickened to increase its life.

Day 3. Last day of the workshop and last day for build.

Picture 19: Detail of the connection piece between the heat riser and the descent tower. Made of what's available in place (better materiales than proposed in the plans). 2 discarded woodburning steel boilers.

Picture 20: Full view.

Day 3. Measuring temperatures. Fire started 18:40pm



Picture 21: 4 spots covered in mud to get a known emmisivity (0,92) for the pirometer

Picture 23: 19:20 pm (40 minutes of burn). Point 1. Reading 121,2 ºC

Picture 24: 19:19pm. Point 2. Reading 88,8 ºC

Picture 25: 19:19 pm. Point 3. Reading: 89.3 ºC

Picture 26: Connection piece, next to the heat riser end. 19:22pm. Reading: 413,5 ºC

	Temperature at point x [ºC]			
Time (start of fire 18:40pm)	1	2	3	4
19:19	121,2	88,8	89,3	-
19:42	190,5	189,1	162,2	26,3

Picture 27: Detail of the contents of ash in the drawers in the morning of day 4.

Picture 28: Leading team for this build (left to right): Ramiro Walti (Hacono), Lucas Gallo Mendoza (INTA), Pablo Kulbaba (Hacono)

Conclusions, observations, learnings:

-As usual, even though we fired the system twice, there’s still need for it to dry and get to know it better. Time is never on our side,specially when we build so far away from home.

-Measurements were done at the time available, but with the system dry, those values should change dramatically. Both in speed of temperature rising speed and in max temperature readings.

-The build had a mixture of planning and doing as-you-go. Examples:

--The addition of the third barrel height for the riser and the descent tower. This implied modifying from the planned 7,5B heat riser to 11,25B. Far from the 10B maximum established in the previous experience.

--The use of the woodburning boilers to connect the heat riser with the descent tower.

-Although the 3 barrel descent tower provided a quick solution for connecting the 4” pipes, seeing the power of the whole device, and the high temperature it will develop, it will represent an extremely hot concentrated spot. So it may be needed to be coated in mud. To be observed.

-The aluminum tape used to seal the connection of the 4” pipes with the descent tower didn’t endure the high temperatures developed. There needs to be a replacement piece in each connection, made by a zinguero, or perhaps the seal can be provided with mud

Things to check, observe, improve in the use of the system:

-Degradation of the steel grill and the steel ash drawers.
-There was a significant air income through the lid of the left ash drawer, perhaps driving the behaviour of the BBR away from the desired. This lid has to ve welded in position.
-Control of burn rate adding a primary air control valve in the door.
-Adding valves in the symmetrical 4" pipes, specially in the top four, so as to enforce the distribution of hot gases to the lower four.
-Measure temperature ant both ends of each 4" pipe to check heat transfer.
-Measure temperature of exhaust gases coming out of brick towers, to check the efficiency of the exchange system.
-The temperature of the exterior walls of the firebox in steady state. If too hot (>100ºC) there will be a need for isolation.

Thanks!
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