Treatment of iron ore with Wakita on the site Of the Muséum du Puits Couriot (Saint-Etienne)

Science Day

Early October 2016

La Mine d'Or de Bissieux

Photos :
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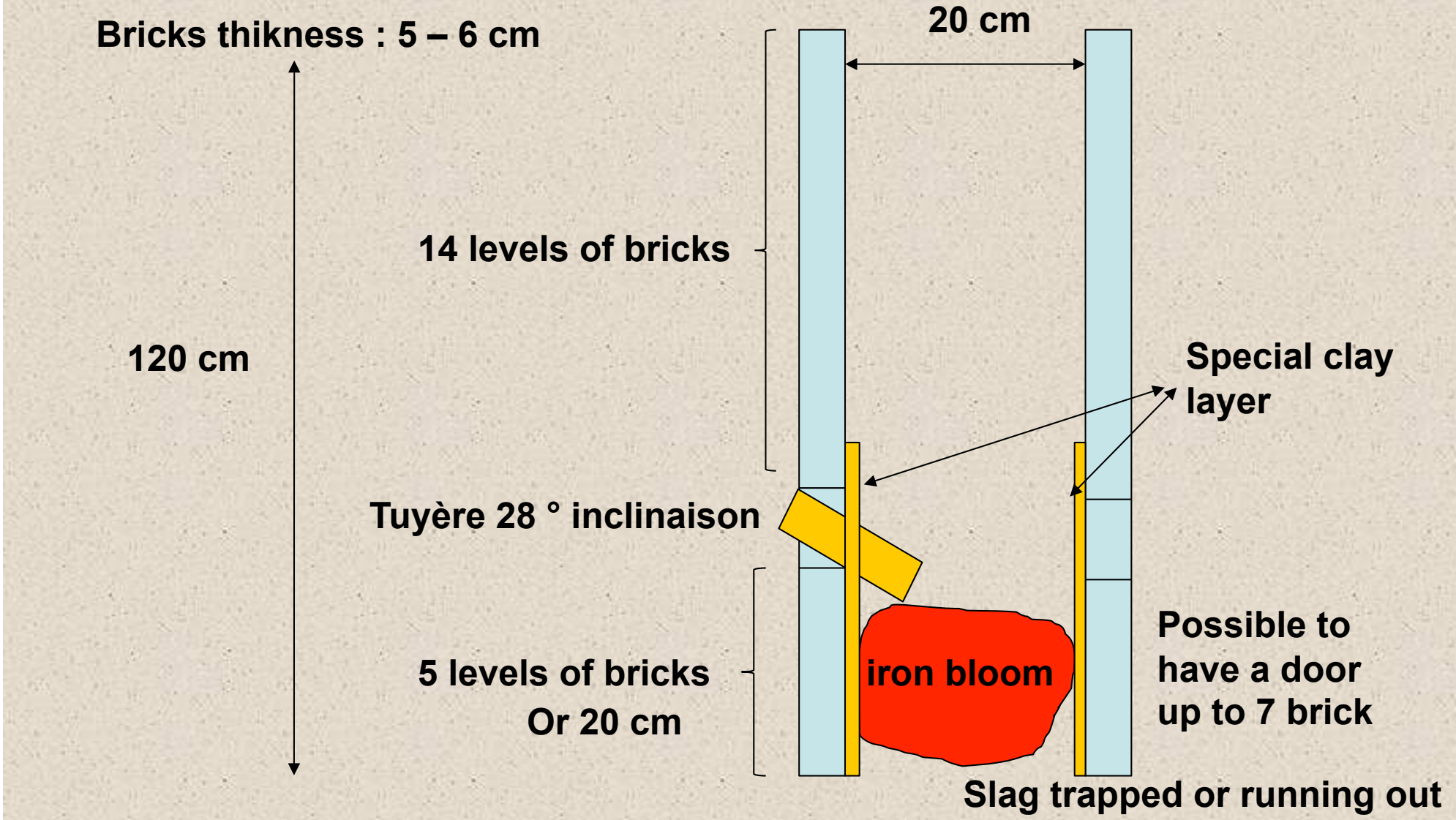
Y.Jounay

Step n°1 : Building the furnace

Special clay (1600°C) covers the inside of the furnace to give it a circular shape and improve the thermal insulation.

This layer constitutes the heating zone under the nozzle and above the nozzle: that is to say the zone where the reduction begins and where the sponge of iron is formed.

Sectional structure of the madman



Step n°2 : reduction operations

Between 9 am and 10.15 am: heating, filling of wood and charcoal, opening of the vents at the base of the oven and closing

Beginning of the reduction operation: 10h15

5 preloads of 500 g of ferrous waste: 1.5 kg

5 preloads of 500 g of ferrous waste obtained during the previous operation at the Bissieux mines with the same grilled minerals as for the heritage days: Total 1,5 kg
Charcoal in basket of 500 g (size of a golf ball)

Introduction of grilled minerals with a 75 g calibrated spoon
3 seals:
Screening <2 mm
Sieve 2 to 5 mm
Screening> 5 mm

ore is load at the opposite side of the tuyere

Each loading is done after descent of a 1 level of brick

Synthesis of chemical reactions in the furnace

Emission of residual vapor and CO2, combustion of reducing gases

Zone de réduction

Melting zone (Kaolin, quartz), vitrification of the pot lining (from 1100 ° C) and agglomeration of the ferrous beads

300 à 500°C :
3Fe2O3 + CO -> 2Fe3O4 + CO2

500 à 800°C :
Fe3O4 + CO -> 3FeO + CO2

800 à 1200°C max
FeO + CO -> Fe + CO2

1200°C à plus de 1300°C :
FeO + C -> Fe + CO

Carburation of iron possible according to temperature

The sponge is formed just below the nozzle with the slag

Follow-up of the loading operations in alternating beds of minerals and charcoal

Heure	Minerais (g)	Charbon (g)
Résidus ferreux		
10h15	600	500
10h25	300	500
10h33	300	500
10h38	300	500
Minerais (tamisage fin <2 mm)	En 4 cuillères	
10h45	300	500
10h52	300	500
11h	300	500
11h05	300	500
11h10	300	500
11h15	300	500
11h20	300	500
11h25	300	500
11h35	300	500
11h40	300	500
11h45	300	500
11h50	300	500
Minerais (tamisage plus grossier entre 2 et 5mm)	En 4,5 cuillères	
11h55	300	500
12h	300	500
12h05	300	500
12h10	300	500
12h15	300	500
12h20	300	500
12h25	300	500
12h30	300	500
12h36	300	500
12h45	300	500
12h50	300	500
12h53	300	500
12h58	300	500
13h01	300	500
13h08	300	500
13h10	300	500
13h25	600	500

Heure	Minerais (g)	Charbon (g)
Minerais (tamisage plus grossier 5mm et plus) 13h32 13h40 13h45 13h50 14h 14h06 14h12 14h16 14h20 14h26	En 4,5 cuillères 450 450 450 450 450 450 450 450 450 450	 500 500 500 500 500 500 500 500 500 500 : fin du chargement
Total	1,5 kg de résidus ferreux 13,5 kg de minerais grillé	21,5 kg (pour la réduction)

End of the reduction process: 1.5 kg of ferrous waste preloaded, then 13.5 kg of toasted ore and 21.5 kg of charcoal for reduction.

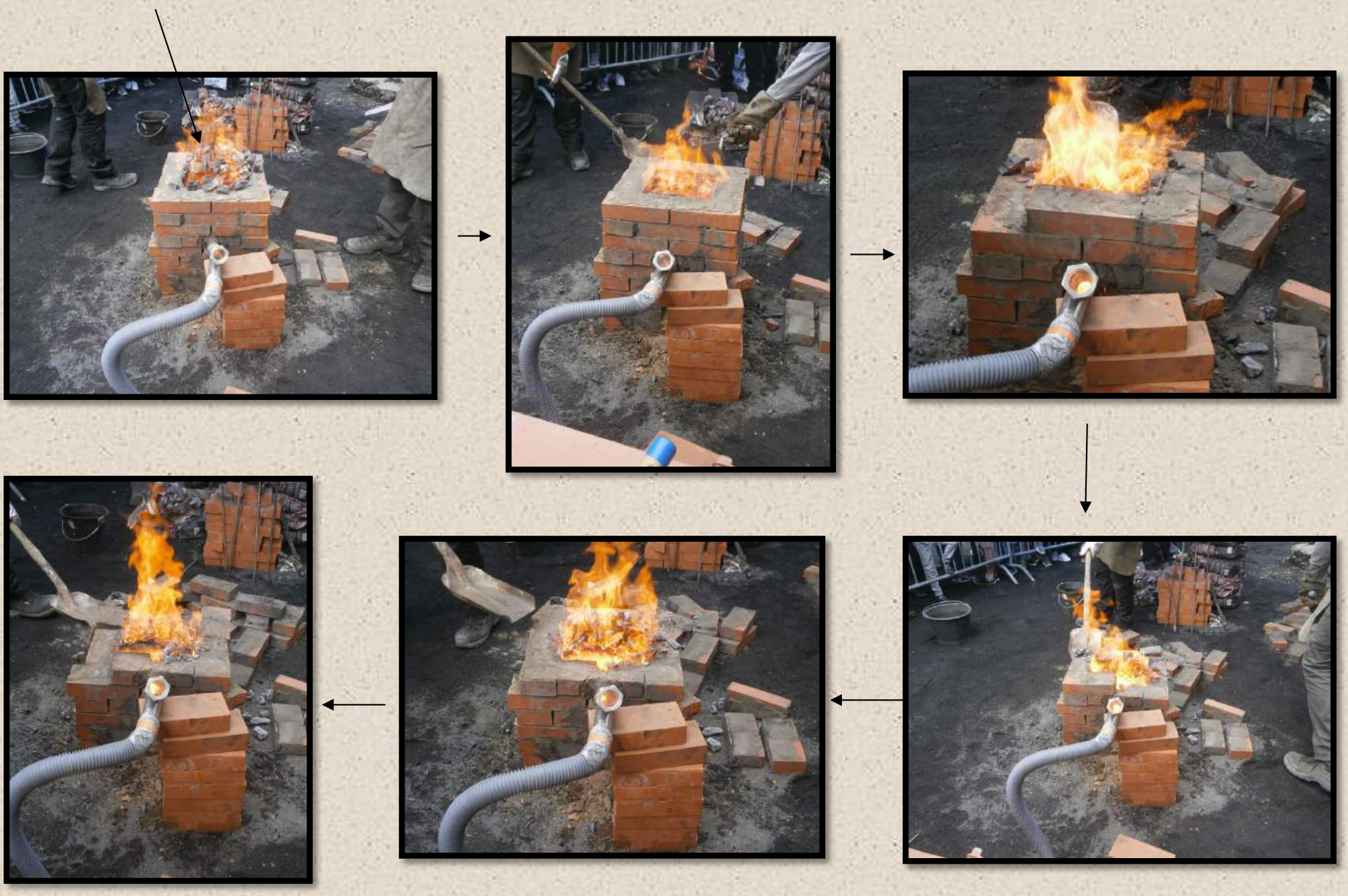
Waiting for the last load of the ore and charcoal from the column (end of reduction) to the tenth brick from the top.

Waiting time of 50 minutes; Burning speed and descent: 5 mn per brick

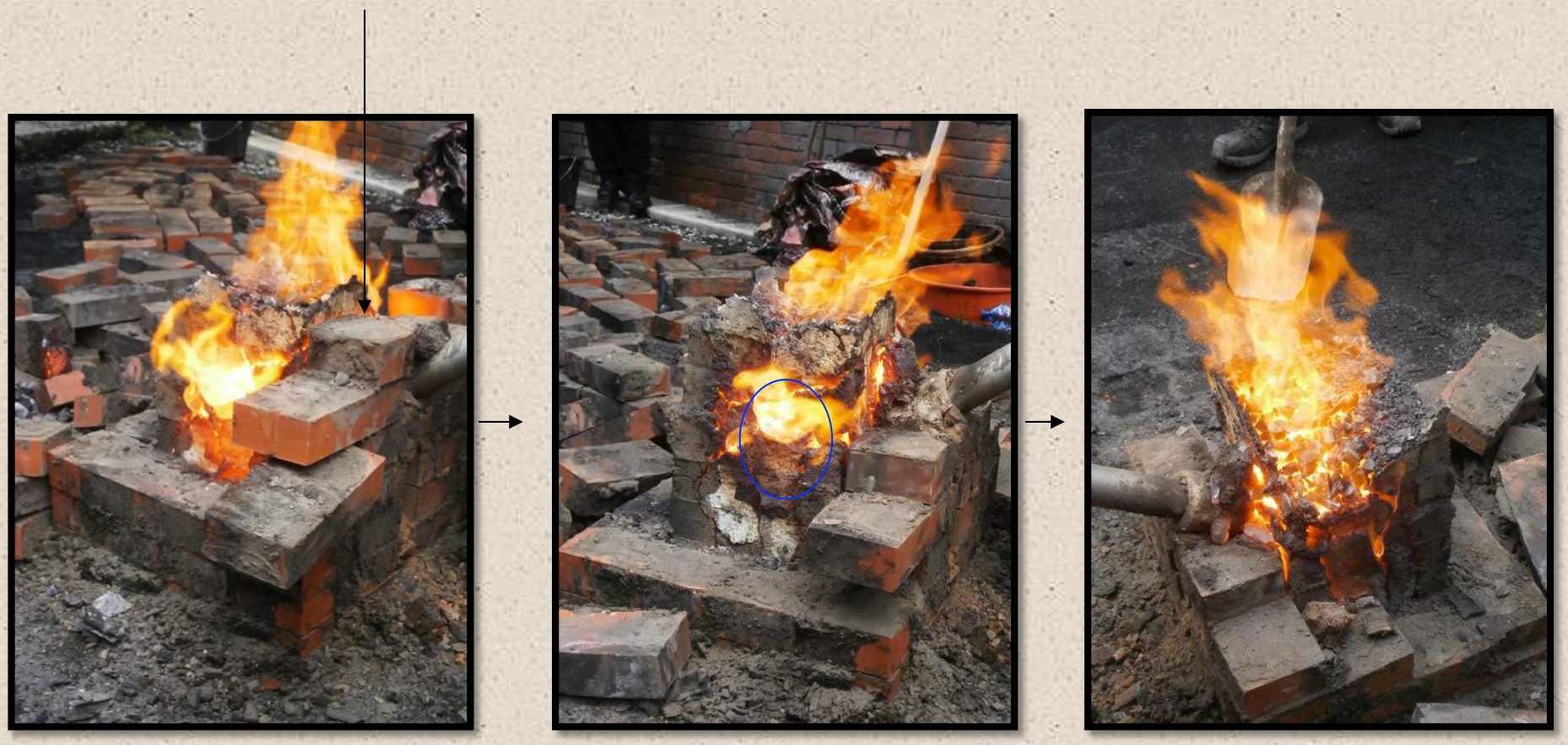
The ore load always get trough the charcoal layers.

Beginning of disassembly of the oven at 15h15 / 15h20

Continued dismantling of the furnace: remaining coal during combustion: 4 bricks above the nozzle zonee



Vitreous clay layer that follows the square shape of the oven: extends a level of brick above the nozzle area



Central zone of the sponge and slag: level of the nozzle

Vitreous clay protection layer that follows the square shape of the oven: extends a level of brick above the nozzle area

Disassembly and presentation of the sponge iron in the pot

Eponge de fer

Extraction of sponge from pot

Extraction of the iron bloom and quenching with water

bloom after spinning

Presentation of the bloom: almost 5 kg

Presentation of the magnifying glass: sponge surface: 3.5 kg

In summary on the profitability approach

* Addition of 1.5 kg of ferrous residues from previous handling with only the same ore.

* Loading in 21.5 kg reduction mode of charcoal.

* 13.5 kg of grilled iron ores.

* Partially reduced recovered ferrous waste: not weighed

* Compact bloom of 3.5 kg.

* Reduction slag: limited and mixed in part with the clay protection layer

No final slag pouring

Total: 3.5 kg / 15 kg = 23.3%

Correct level of profitability in line with the type of ore used.

Furnace Team

Adrien Morat: Master of the furnace.
Remi Matricon: assistant to conduct the oven and extract the sponge.
Yves Jounay: assistant conductor of the bellows
Emmanuel Dransart: metallurgist, assistant conductor of the furnace

Standard parameter of the wakita:

- 240 m^3 of air / hour
-Air pression about 0,5 Psi (same as you blow air from our mouth on your hand)
-Diameter of the tuyere is 30mm inside the furnace to 50 mm out,
-Pipe that brings air from the below is 50mm dimeter

Form overs questions about the reduction you can email me to
morat-adrien@orange.fr

Thanks all