Rocket stoves for marine trash utilization (Preliminary concept of K or L and T form)

Totok Hestirianoto[1*], *Irzaman* Irzaman[2], *Sri* Pujiyati[1], and *Steven* Solikin[1]

[1]Departement of Marine Science and Technology, Faculty of Fisheries and Marine Science, IPB University, Bogor 16680, Indonesia
[2]Departement of Physics, Faculty of Mathematics and Natural Sciences, IPB University, Bogor 16680, Indonesia

Abstract. Two types of Rocket-stoves had been built and developed, the type L or K and the type T. Both types had been made to consume the woods from the washed materials in the river bank of estuary. The two types had worked very well, the first one, the L or K type had only one intake of oxygen. Meanwhile the second one or T type had two oxygen intakes. Second attempt as a result of the first stove of the rocket stove. The L or K model was made of 7x7 cm steel material. It was a square tubular steel pipe. The leg of "L" or "K" shape was made of 30 cm long tubular steel. The base was pipe the oxygen intake, and the upright pipe was the exhaust or the heat outlet, and the rest was wooden intake. Meanwhile the "T" model was made of 3 inches metal circular with 60 cm long and 15 cm height. The 15 cm long pipe was erected in the middle of 60 cm long pipe. The 60 cm long pipe or horizontal pipe was the port for fresh air, the 15 cm for the heat or burned coal.

1 Introduction

The IPB have invented the stove using the husk [1]. People also try to modify the stoves by using compost and the gas produce from composting the materials. Moreover they also try to tap the energy from the sun. During the no sun days or the sky covers with clouds they cannot use the stoves. The people prefer to use a practical way, direct burning them. Since 2014, the performance of the biomass stoves has been in the topic of research [2]; The trash wood from cloves [3]; and the coconut bricket [4]; and even the Sengon or sandal wood [5].

Fire-Wood became the topic of daily talk or conversation. Due to easiness, it is then the way to find it in the drifting material [6], and also by calculating the basic form [7], until the exhaust port [8]. Primarily, it is a simple as putting inside the wooden chip in the furnace, or a twig or a re-useable material to the furnace. In marine condition, the woods can be collected along the river bank and also the coastal, particularly during the floods. The woods are drifted from the uphill area and it will be washed to the downhill area. The people collect it to be dried and used it as fire woods.

* Corresponding author: totokhestirianoto@apps.ipb.ac.id

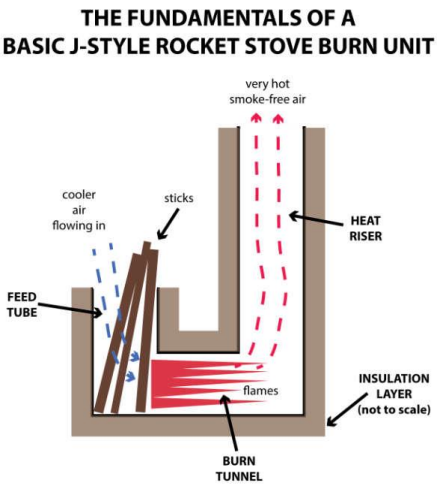

Fig. 1. Basic design of J-shape stove [9]

Basically, we try to build rocket stove, then we also distribute them to the users or people around the campus, IPB University. The difficulties of the people in the kampong to find the burning stuff made us to think the suitable of stove. The model is made of material that is to find, and also the knowhow which match to the locals. Thus the efficiency of the stove we give.

2 Materials and design

The first model or type L or K was made of square hollow steel, a hollow square steel pipe of 7x7 cm. Figure 2 shows the basic design of K form or L form.

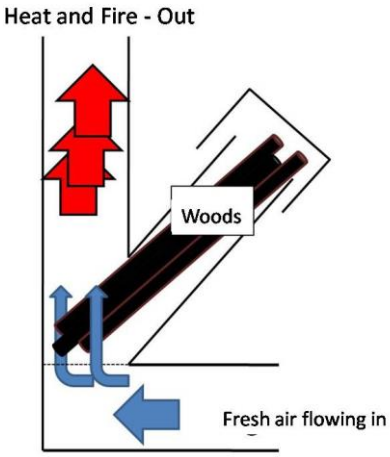

Fig. 2. The basic design, was the K or L form. The air flowing was from the bases. It rose vertically to exhaust. The oblique way was the firewood port.

The second type or T type was slightly different. It was a stove of dual port intake model. It is more simpler than the single port intake.

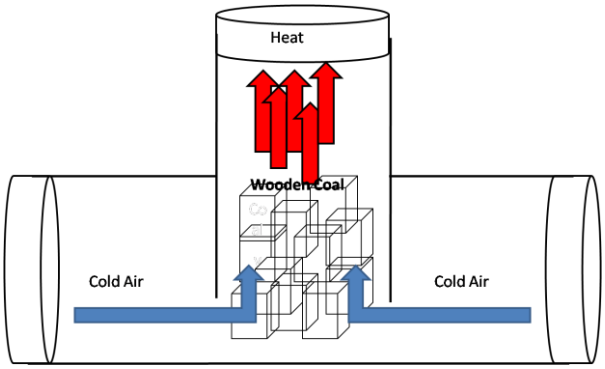

Fig. 3. Simple diagram of dual intake port stove

The fresh air (due to double intake) was guaranteed to flow into burning chamber. It was easier to build rather than single port model. It was made of pipe of three inches in diameter. The 60 cm long for air intake and 15 cm height for burning port. In general it was to form a letter "T". The Heat was in the middle, and the fire would burn the wood easily. The weakness was the refilling process the wood. Every time it needed to fill up the wood we have to stop the cooking, and fill the stove.

3 Results and discussion

3.1 Result from stove type L Or K

The stove actually consists of three ports. Theoretically the first flows from firewood input-port to heat or fire output-port. The second time is from fire, where it flows to the throat (port 3) and then it flows to the exhaust port or port 4. Thus the fire is getting fresh air from port 1 and port 2, and then flowing into port 4 as fire or hot air.

Fig. 4. Air input-port, firewood-port and fire output-port

But, based on the infra-red reading, it also flows the heat in other ways. The fresh air is coming from port-1. It charges the fire in port-3 but also burn the coal or wood. The heat

which is flowing from port 2 and also flow to the 4. Port 2 becomes the air supply but it to burn the coal. But on the contrary port-2 had two functions, first it blows fresh air to burning coal, and when the heat has built up it flows not to port 4, but it flows back to port 2.

Fig. 5. Rocket Stove type L or K

Most of the temperature is measured under 100 °C. It can be the heat flow is too fast and also the material is thick enough. Generally the tested stoves was equal which is didn't increase the heat to above 100 °C. Both of the stoves reached maximum degree of only 80 °C degree.

Table 1. The Heat record for every port (°C) made by infrared thermometer, for every position of port.

Port 1	Port 2	Port 3	Port 4
71.1 - 49.1	72.6 - 52.9	72.3 - 50.4	73.0 - 52.9
72.9 - 52.8	74.3 - 74.3	73.8 - 54.1	74.7 - 54.8
74.4 - 54.8	75.5 - 57.1	75.0 - 56.8	76.0 - 57.4
76.6 - 57.3	78.0 - 78.6	77.8 - 57.8	78.3 - 59.1
78.1 - 59.0	73.4 - 60.3	79.2 - 60.2	79.8 - 61.5
79.3 - 61.5	80.1 - 63.3	80.1 - 62.9	80.3 - 63.7
79.9 - 63.2	80.9 - 65.1	80.6 - 64.5	81.1 - 65.6
80.6 - 65.6	81.3 - 66.9	81.3 - 66.4	81.4 - 67.8
81.1 - 67.9	81.7 - 68.8	81.6 - 68.6	81.8 - 69.9
81.5 - 69.9	82.0 - 71.3	81.9 - 70.8	82.1 - 71.8

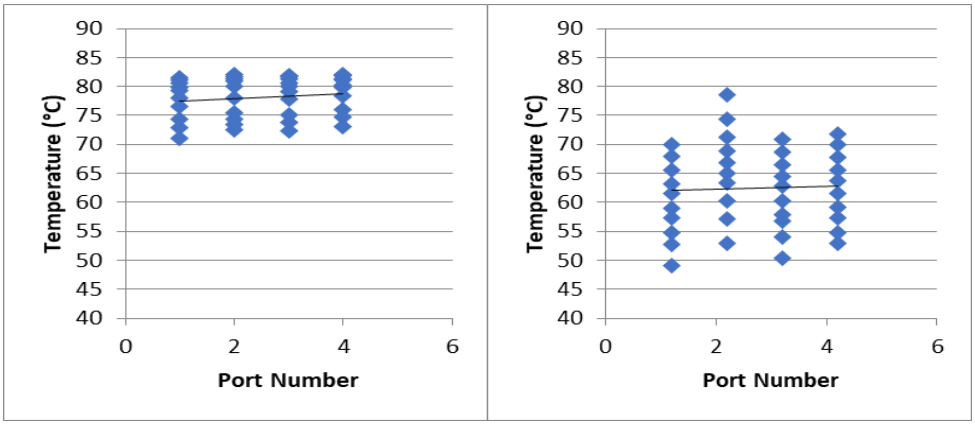

Fig. 6. The performance of Stove 1 (left) and Stove 2 (right), the trend line of Y=0.428X+77.11 (left) and Y=0.241X +61.76 (right)

3.2 Result from stove type T

The modification had success to increase the heat. The fire was becomes larger. The fire was distributed well, because the shape of burning outlet was circular. The vortex outflow would be pushed the fire to concentrate in the middle. The vortex would push the fire to concentrate in the middle.

Dual intake port, would make it easy to turn fire on. Two-ports was easy to supply the oxygen or fresh air for both of sides, left and right of the fire. The benefit of the two-port came from the much of fresh air flew in. But it was difficult to control the incoming air and also putting it in the center. Thus it would result to generate a vortex force. The vortex force would push the fire to concentrate in the middle, but unfortunately it will consume more coal. Result from the laboratory showed the best performance of the stove. As many as two stoves were made during the examination. The whole study relied on two stoves.

Fig. 7. Point of measuring the performance of the stove

Table 2. Infrared reading from rocket stove type T (Pooled Data)

Port 1	Port 2	Port 3	Port 4
44.3- 46.1	49.6- 48.7	187.9- 201.4	114.1- 287.4
42.1- 51.8	46.7- 48.4	165.5- 214.3	101.1- 278.1
44.1- 45.9	50.3- 48.3	154.1- 268.2	109.0- 245.4
44.1- 45.6	42.4- 48.4	219.5- 233.9	198.6- 249.5
40.8- 49.1	43.7- 51.8	191.1- 243.7	221.6- 232.8
39.1- 48.4	42.4- 52.8	163.2- 240.3	237.2- 237.6
39.9- 52.1	48.4- 50.8	191.4- 236.5	238.3- 219.2
44.3- 48.8	44.4- 51.7	188.8- 236.6	241.8- 210.6
42.6- 43.9	51.7- 48.9	166.5- 264.9	242.1- 181.7
42.8- 48.1	47.0- 48.8	186.1- 235.3	242.1- 228.0

The fresh air from Port 1 and Port 2 had successfully flew to throat of the stove (Port 3) and then it burned to the Port 4, The trend line was Y = 67.30X – 38.5 (Pooled Data).

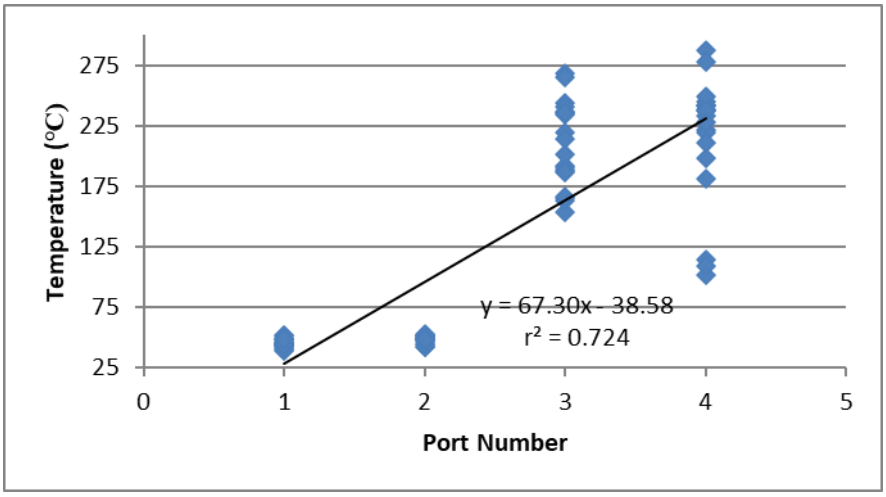

Fig. 8. Performance of the two stoves (pooled data), the trend line was Y=67.30X-38.58, r^2=0.724

The both data, clearly seen that the trend line was Y=50.72X-8.316 and Y=73.96X-101.2, it had a very good trend line with r^2 = 0.774 and r^2 = 0.763. Meanwhile performance of the second attempted it had better result. The trend line was r^2=0.953 and r^2=0.953, with Y=63.01X-15.03 and Y-63.67X-137.6. It means that the second type of rocket stove (type T) showed a better result.

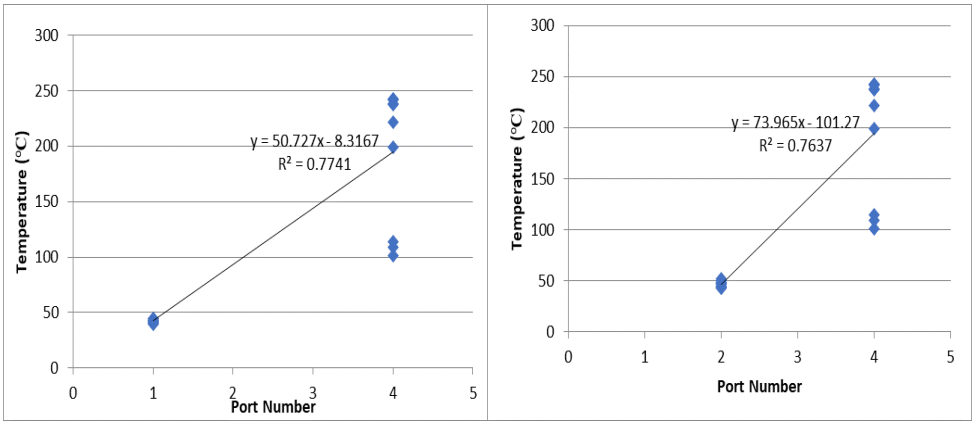

Fig. 9. Performance of Stove-1. The trend line from port-1 or port-2 to port 4 were Y=50.72X-8.316 and Y=73.96X-101.2 r^2=0.774 and r^2=0.763 respectively

We hoped that to gain the best result, it was needed to wrap the tubular body with the cement or gypsum. The gypsum or cement will protect the heat from sipping out. Thus the heat from port 1 or 2 will flow direct to port 4. It will increase the R^2 higher.

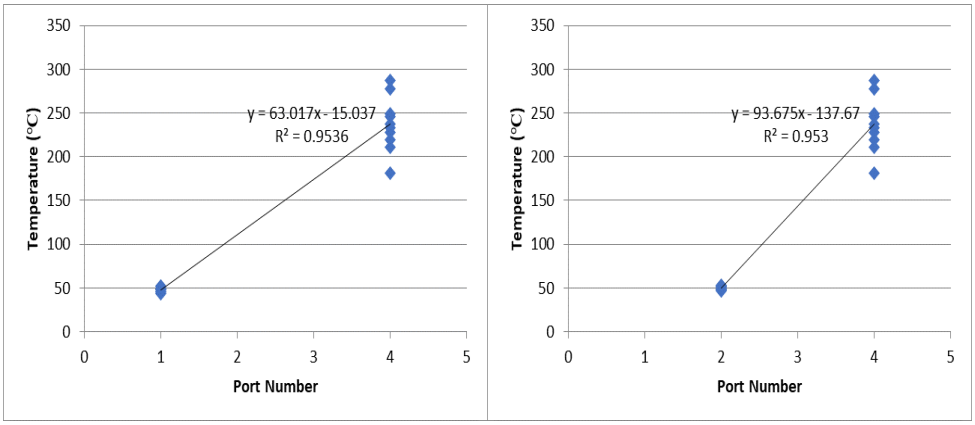

Fig. 10. Performance of Stove-2. The trend line from port-1 or port-2 to port 4 were Y=63.01X-15.03 and Y=93.67X-137.6 r^2=0.953 and r^2=0.953 respectively

4 Conclusions

The concept of the K or L form has been successfully built. But the flow of the heat has proofed that the whole body become hot. It needs some improvement to the stove such as to close the port 2. The stove type T has improve the stove. But the woods consumption is really high. The two models needs some improvement to make it better

We would like to thank you for the laboratory of Physic Faculty of Mathematics and Natural Sciences for lending the equipment, namely the infrared gun for this research.

References

1. Irzaman, H. Siti, N. Patonah, Irmansyah, Z. Mahfuddin, J.R. Prasta, H. Hendradi, IPB Press (2023).
2. R.H. Purnomo, E.A. Kuncoro, D. Wahyuni, Buana Sains. **14**, 2 (2014).
3. R. Wakur. H. Rawung, R. Molenaar, D.P. Ludong, Cocos. **6**, 13 (2015).
4. P Sampelawang. Dynamic Saint, **3**, 1 (2017).
5. N.I. Wibowo & M.R.B. Arief, Agroscience. **10**, 2 (2020).
6. S.D. Kurniawan & B.T. Sasongko, Senatik. **4**, 2018.
7. P. Tabah, S.R. Arif, Darmanto, Momentum. **14**, 1 (2018).
8. D.Z. Arrahma, N.A. Tasya, I. Febriana, Y. Bow, A.S. Ningsih. J. Pendidikan dan Teknologi Indonesia. **1**, 11 (2021).
9. J. Meadow & D. Palmer, Permaculture Principles (2018).