International Journal of Sciences: Basic and Applied Research (IJSBAR)

ISSN 2307-4531
(Print & Online)

http://gssrr.org/index.php?journal=JournalOfBasicAndApplied

Design of Liquid Smoke Pyrolysis on Red Brick Burning in 'Smoke Village' (Case Study of Kalipucang Kulon Village-Jepara District)

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Abstract

The issue of air pollution has become a global issue that continues to roll as a consequence of modernity and human activity. The high rate of air pollution and increased disease in humans has spawned a new framework of global partnerships for development that can be called the term SDGs or Sustainable Development Goals. Development and economic growth must be balanced with the maintenance of health, welfare and environmental sustainability. Kalipucang Kulon village located in Jepara-Indonesia regency, has the potential of superior product of the village in the form of red brick. More than 80 percent of families or 1,500 households in the village work as red brick artisans. The high production of red brick has caused Kalipucang Kulon Village to be called by residents as smoke village. Burning bricks in the traditional way causes air pollution that has reached dangerous levels. This is evident from the high number of patients with ARI in the village with an average of 180 case findings per month. The development of liquid smoke pyrolysis in red brick combustion process is expected to reduce air pollution, increase revenue from liquid smoke sales, and in the long run can decrease the number of cases of ARI disease.

Keywords: air pollution; red brick; ARI; liquid smoke; pyrolysis.

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1. Introduction

Red brick combustion smoke has become one of the sources of air pollution in the village of Kalipucang Kulon, because the red brick manufacturing is indeed in the middle of the village in front of residents' houses. This smoke can make people breathless and at high risk of increasing the occurrence of cases of ARI and Penumonia. The cause of death of pneumonia is highest due to burning with firewood, or furnace as much as 93.2% [1].

In developing countries, traditional combustion uses wood, agricultural waste and animal waste into the main source of energy, and the most frequently exposed to traditional combustion pollution are women and children [2]. About 50% of people in developing countries use charcoal, timber, animal waste, and crop residues for kitchen burning [3]. These materials are burned in simple combustion with incomplete combustion. Consequently, women and children are exposed to high levels of indoor air pollution every day for 3-7 hours per day for several years.

Other problems faced by society is not only the problem of ARI disease, but from the economic aspect. Most of the population (80%) depend on the red brick industry. In fact, the income of workers in the brick industry is not compatible with the energy used. Indeed, some of the population Kalipucang Kulon is producing red bricks in front of their houses in the middle of the settlement, ranging from blocking to burn it.

The development of red-burned brick smoke is considered important and urgent when viewed from the perspective of alternative health and income for the villagers. Liquid smoke has many benefits for everyday life. The liquified smoke has been developed as food preservative agent, food antioxidant and biopesticide [4]. It consists of dispersed gas-phase in water system [5,6,7]. Furthermore, composition and organoleptic properties of the liquefied smoke fundamentally depends on pyrolysis temperature, quantity of oxygen, humidity, particle size, apparatus type and raw content materials such as wood characteristics [8].

Based on information from Clinic Kalipucang Kulon Village, when the dry season recorded that per month can occur more than 250 cases of ARI. Most ARIs are caused by high smoke pollution due to increased redbrick production during the dry season [9]. This smoke pollution is not only happening outside the room, but also at night the smoke is getting thicker into the homes of citizens [10]. The amount of smoke in this village causes the village to be called Smoke Village. Specifically, this study would like to see how effective the use of pyloric method in reducing the impact of smoke on the environment and how much liquid smoke it produces from the burning of red brick.

2. Method

2.1 Data Collection Method

This study uses primary and secondary data related to Kalipucang Kulon village health profile, primary data from liquid smoke production in trial warehouse and other secondary data. Source of data came from Kalipucang Kulon Village, Welahan I Health Center, Jepara Health Office, and BPS of Jepara Regency. The types and sources of data in detail can be seen in the table below.

Table 1: Types and source of data

No	Type of Data	Source of Data
1	Potential Village Data 2017	Central Bureau of Statistics
2	Village Monograph Data 2017	Village Government
3	Health Profile Data of Jepara Regency	Health Office of Jepara District
4	Data on the number of cases of ARI Kalipucang Kulon Village 2017	Village Government
5	Data of brick construction of Kalipucang Kulon Village	Village Government
6	Data of Liquid Smoke Production	Liquid Smoke Experiments in the Village

2.2 Data Analysis Methode

This research uses quantitative descriptive analysis, trial case study and financial analysis of liquid smoke business development. The design of the liquid smoke apparatus used in this study is a pyrolysis method using a copper cooling pipe [11]. This liquid smoke-making apparatus is tested in red brick kiln to see the effectiveness and efficiency of liquid smoke produced [12]. Liquid smoke that has been produced then tested on agricultural crops such as chili and tomato. Trials are also conducted to overcome the diseases of flea and fungi in cattle. To examine the extent to which the liquid smoke fluorine pyrolysis development trials are financially feasible, financial analysis of benefits and cots (B / C) and Payback Period (PP).

3. Result

3.1. Development of Tool Design

The cooling tank is made of metal like a drum in which there is a pipe circle connected to the smoke removal pipe from the furnace. The cooling tank is installed so that the smoke can be turned into liquid.The large pilling tube is made of metal and there is a drain pipe for the surrounding liquid smoke covered with red bricks and clay to avoid conduction heat and radiation. Each pyrolysis tank can accommodate 300 liters each time the filtration process occurs 40-50 liters of shrinkage.

The pyrolysis tool used is made of aluminum plate 2.2 mm diameter of 70 cm and 95 cm high with 200 liter capacity. The series of distillation tool then made a holder of iron measuring 3x3 cm so that the shape of the tool can be seen in the picture below. A series of liquid smoke dispenser pipes are made of 5 mm long 5 mm diameter copper pipe made of turns so that the evaporating liquid is easy to melt again. A circular winding circular pipe is placed in a water reservoir connected to the faucet so that the coolant flow runs constantly to maintain the cooling temperature

Figure 1: Design of Liquid Smoke Destilator

3.2. Making Brick Burning Warehouse

Red brick arsenal built with a capacity of 4,000 seeds and made of teak wood with red tile roof. The size of this burning arsenal is 6 meters x 10 meters and 4 meters high. Burning warehouse is also an existing warehouse residents who are willing to build liquid smoke equipment. Since the arson warehouse belongs to the residents, the devotion team modifies the right and front cover with the tarpaulin. The goal is that the smoke from the burning husks can be captured by the suction apparatus and not much wasted [13][14].

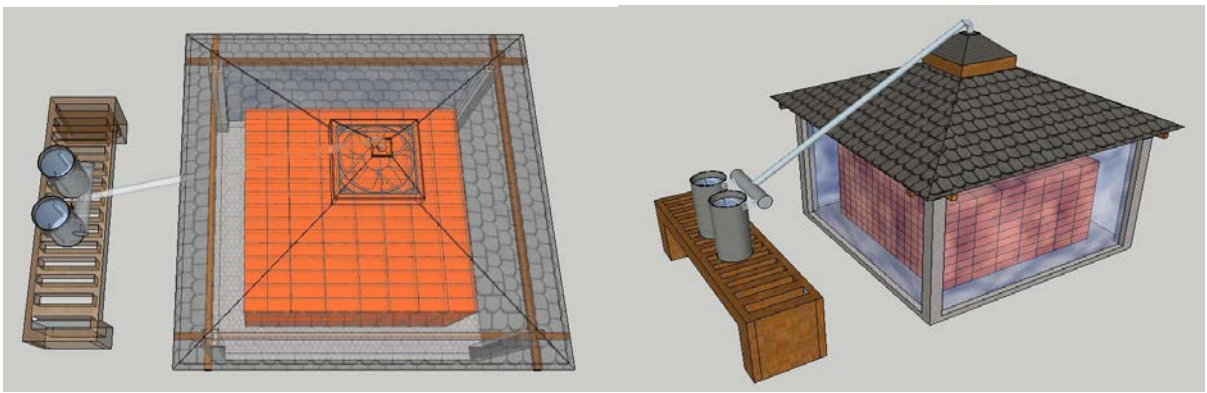

Figure 2: 3D Burning Warehouse Design

The smoke flow pipe is made of iron 3 inches with 1.2 mm. The pipe is made of a 8 meter long winding and coupled with a 6-meter cooling tube with a size of 3 inches and a diameter of 5 inches. To smoke the chimney

used with a size of 16-inch exhaust. This mechanism passes smoke through an iron pipe and holds in a condensing tube that will turn into liquid smoke. The first liquid smoke that came out was class 3 that was brownish and smelled strongly of smoke [15]. In addition to liquid smoke, pyrolysis tools also produce ash from rice husk burning in liquid smoke production process [16].

Liquid smoke that has been accommodated in jerry cans that have been separated according to each gradenya, then packed and labeled. Liquid smoke packaging according to customer demand based on grade and amount of liquid smoke ordered, if no order is only stored on jerry cans. However, until now, the resultant smoke from the new rice husk combustion can produce grade 3 liquid smoke. Liquid smoke packing can be broken down into 500 ml sizes up to 2,000 ml

Figure 3: Liquid Smoke Packaging

Red brick combustion using modified warehouse model with blue wall covering. Burning red bricks in this way is believed to increase red brick maturity faster because the smoke can be collected maximally in the warehouse, and the heat of the fire is not easily lost due to the wind. The duration of red-brick combustion is generally done for 4 days, but in the experimental warehouse can be seen under the burning of red brick can be faster to 3 days of burning.

The result of this combustion generates a very economical advantage for red brick entrepreneurs. This increased economic value is due to increased burning productivity which was originally only able to burn 6-8 times in a month can be increased to 8-10 times in a month. This increase is also offset by a decrease in smoke pollution resulting from the burning of red bricks by rice husks.

The total liquid smoke obtained in one combustion process is 30 liters derived from 800 kg of burned rice husks. Based on these results it can be seen that the combustion efficiency of liquid smoke compared with the amount of raw materials burned is 3.25 percent. The production of liquid smoke is relatively small when compared with the pyrolysis that can achieve a maximum efficiency of 40 percent (Ikhwan 2007).

Achieving efficiency of 3.25 percent is caused by several factors, including the following:

a) The high leakage remains on the barrier wall using plastic sheeting so that the smoke does not exit

maximally through the cooling pipe;

b) Weather conditions in Kalipucang Kulon Village (Jepara regency) during the very hot day so that the smoke cooling process becomes not optimal;
c) Wind motion around the service area affects the continuity of the smoke flow through the cooling pipe;
d) The construction of the cooling pipe is still not maximal in cooling the smoke so it needs to be extended;
e) The form of burning arsenal that can not be closed maximum so that it is very risky to cause leakage;
f) The use of exhaust less than maximum sucotnya power, so that the smoke into the pipe cooler less than the maximum.

In the process, it takes an electric current with a minimum power of 25 watts to be able to turn on the exhaust of the vacuum cleaner. Then the warehouse should be sealed with tarpaulins so there is not much smoke coming out of the arsenal. The combustion process begins by turning the rice husk to burn the red brick for 3 days. Make sure the outlet is tightly closed, the process takes about 10 hours each day and produces 10 liters of liquid smoke, so that if the process of pyrolysis for 3 days, it can produce liquid smoke as much as 30 liters. This pyrolysis process will produce grade 3.

3.3. Liquid Smoke Benefits for the Community

Testing of liquid smoke obtained from the red brick combustion process conducted on chillies and tomatoes. The form of the experimental formulation was carried out with three variations: (1) 100% liquid smoke, (2) mixing liquid smoke with water using a ratio of 1: 10, and (3) mixing liquid smoke with another organic material 1 liter liquid smoke in addition to ½ kg leaf distance, ½ kg of leaf imba, and 1 liter of water. The experiment was done by spray method on 6-week-old plant. The disease that attacks the tomato plant at the experimental site is a white fungus that causes the leaves to become dry. In chilli plants, diseases that attack almost the same. But in this chilli plant is black [17].

The result of application of liquid smoke as organic pesticide applied at experimental location around Kalipucang Kulon Village still has not seen significant influence. Pests found in tomato and chilli plants still exist. The result is a tomato becomes dwarf, critic, and leaves dry out. A comparison of other peasant plants using chemical pesticides also showed the same thing. This same pest attacked all the farmers' tomatoes in Welahan sub-district almost the same, so this research still needs a formulation of liquid smoke mixture that can control the pest. The results of experiments on small chillies showed better progress. The existing pests have decreased significantly so that harvest can still be done. Thus liquid smoke formulation can be an alternative for farmers to make production costs cheaper. Larger scale production is possible, making it an additional income for red brick craftsmen

Testing of liquid smoke as livestock medication is done on broiler breeders in Welahan District. The disease that most of the cattle suffer is itching and redness. Liquid smoke is given once a day in the severely ailing section. The experimental results show that the sick cow can heal within 1 to 2 weeks. Liquid smoke can also be applied to prevent mosquito bites that usually cause bleeding in the feet and joints of the cow [18].

Based on the result of the application of the development of the smoke smoke apparatus which is used to suck the smoke of red brick combustion, it can be seen that this liquid smoke suction device can reduce more than 60-70 percent of combustion smoke [19,20]. There is still residual smoke coming out due to semi-permanent arsenal of arsenal, using wooden frames and atam. In addition, the burning warehouse design is closed using a tarp that has quite a gap on the edges of the tarpaulin. If it can be applied en masse or more number, it is not impossible the use of this smoke can reduce the impact of ARI disease caused by air pollution [21,22] .So one of Jepara regency health development output can be achieved in the form of decreasing the amount of amount patients with ARI in Kalipucang Kulon Village. The number of residents who suffered from ARIs due to exposure to husk-burning smoke can be reduced by up to 80% [23,24].

3.4. Financial Analysis

Based on the calculation of financial feasibility of B / C, investment cost in the first year is Rp. 22.070.000 with monthly expenses of Rp. 5.400.000 and can achieve monthly profit of 2,400,000. Enterprises will turn back in the second year. This result can be said to be less economical because the size of the warehouse with a capacity of 3,000 bricks is considered still minimalist, because the cost of combustion becomes increased, the capacity is too small (less economical), and the smoke cooler used today can be used there warehouse with a capacity of 8,000 bricks.

Table 5: Fixed Capital Expenditures

No	Type of work	Volume	Unit	Unit price	Price (Rp)
1	Smoke Cooling Pipe	1	Set	15.000.000	15.000.000
2	Foundation and Locking	1	Set	1.000.000	1.000.000
4	Liquid Smoke Container Drum	1	Item	150.000	150.000
5	Jerigen Capacity 30 Liters of liquid smoke container before purification	4	Item	40.000	160.000
6	Jerigen Capacity 30 Liters of liquid smoke container after purification	4	Item	40.000	160.000
7	TAR container and residual sediment deposition and distillation capacity of 30 liters	4	Item	40.000	160.000
8	Exhaust	1	Item	40.000	40.000
	Total	16			16.670.000

Table 6: Variable Capital Expenditures

No	Expenditure	Monthly (Rp)	Annual (Rp)
1	Cost of Liquid Smoke Rp. 100,000 per warehouse x 4 times burning per month	400.000	4.800.000
2	Cost of Maintenance and Depreciation of equipment	50.000	600.000
	Total	450.000	5.400.000

Table 7: Liquid Smoke Sales Assumption

Description	Unit	Total
Number of husks burned 500 kg x 4 times combustion	kg	2.000
Liquid Smoke Results (3,25 persen)	Liter	65

Table 8: Liquid Smoke Sales Income

Income	Monthly (Rp)	Annual (Rp)
Liquid Smoke Results (65 liter x Rp 10.000)	2.400.000	28.800.000

Table 9: Benefit and Cost of Production and Sale of Liquid Smoke

Year To	Cost/Year (Rp)	Total cost (Rp)	Benefit/Year (Rp)	Total of Benefit (Rp)	B-C (Rp)
1	22.070.000	22.070.000	28.800.000	28.800.000	6.730.000
2	5.400.000	27.470.000	28.800.000	57.600.000	30.130.000
3	5.400.000	32.870.000	28.800.000	86.400.000	53.530.000
4	5.400.000	38.270.000	28.800.000	115.200.000	76.930.000
5	5.400.000	43.670.000	28.800.000	144.000.000	100.330.000
6	5.400.000	49.070.000	28.800.000	172.800.000	123.730.000
7	5.400.000	54.470.000	28.800.000	201.600.000	147.130.000
8	5.400.000	59.870.000	28.800.000	230.400.000	170.530.000
9	5.400.000	65.270.000	28.800.000	259.200.000	193.930.000
10	5.400.000	70.670.000	28.800.000	288.000.000	217.330.000

4. Conclusion

Pengembangan pilorisis asap cair dapam prosem pembakaran bata merah merupakan salah satu cara moderat dalam mensukseskan SDGs. Pada satu sisi target pengembangan kesehatan bisa tercapai dengan adanya penurunan produksi asap di desa. Pasa sisi lainnya aktivitas pembakaran bata merah yang mendukung pertumbuahan ekonomi bisa tetap berjalan, bahkan ditambah dengan adanya penghasilan dari produksi asap cair yang bernilai ekonomis.

Acknowledgements

We would highly appreciate to IbM Program from Ministry of Technology Research and Higher Education for research financial support.

References

[1] Savitha, M.R. et al. (2008). Modifiable risk factor for acute lower respiratory tract infections. Indian Journal Pediatric, 27 (5): 447-481

[2] Kilabuko, J.H.; Matsuki, H.; Nakai, S. 2007. Air Quality and Acute Respiratory Illness in Biomass Fuel using homes in Bagamoyo, Tanzania. Int. J. Environ. Res. Public Health, 4, 39-44.

[3] Bruce, N. et al. 2000. Indoor air pollution in developing countries: a major environmental and public health challenge. Bulletin of The World Health Organization 2000. Vol.78 (No.9):1078-1092.

[4] T. Nurhayati. 2000. Sifat destilat hasil Destilasi kering 4 jenis kayu dan kemungkinan pemanfaatannya sebagai pestisida. Buletin Penelitian Hasil Hutan 17: 160-168

[5] Darmadji, P. 1995. Produksi asap cair dan sifat fungsionalnya [Laporan Penelitian]. Yogyakarta: Fakultas Teknologi Pertanian, Universitas Gadjah Mada

[6] Darmadji, P. 1996. Aktivitas antibakteri asap cair yang diproduksi dari bermacam- macam limbah pertanian. Agritech, 16: 19-22.

[7] Darmadji, P., 1999. Sifat Antioksidatif Asap Cair Hasil Redistilasi Selama Penyimpanan. Prosiding Seminar Nasional Pangan, Pusat Antar Universitas Pangan dan Gizi UGM, Yogyakarta.

[8] Girard, J. P. 1992. Smoking in Technology of Meat and Meat Products. Ellis Horwood, New York.

[9] Koch, A. et al. (2003). Risk factors for acute respiratory tract infections in young Greenlandic children. American Journal Epidemiology, vol 158 (4): 374-384 (14 September 2012).

[10] M.K. Ihwan, S. Pramono. 2008. Pembuatan Asap Cair dari Pembakaran Sekam Padi Pada Proses Produksi Batu Bata. Thesis. Universitas Gajah Mada

[11] Haji, A.G, Zainal A.M, Bibiana W.L, Surjono H.S & Gustan P. 2007. Karakterisasi Asap Cair Hasil Pirolisis Sampah Organik Padat. J. Tek. Ind. Pert. 16 (3) : 111-118.

[12] Atmaja, A.K. 2009. Aplikasi Asap Cair Redestilasi Pada Karakterisasi Kamaboko Ikan Tongkol (Euthynus Affinis) Ditinjau Dari Tingkat Keawetan Dan Kesukaan Konsumen. Skripsi. Surakarta

[13] G.M. Agung, M.H.S Rizal, P. Mardina. 2013. Ekstraksi Silika Dari Abu Sekam Padi Dengan Pelarut KOH. Konversi. 2 (1) : 1

[14] Bridgwater, A.V. 2004. Biomass fast pyrolysis. Thermal Science Journal, 8: 21-49.

[15] Tranggono, B. Suhardi, P. Setiadji, Darmadji, Supranto, Sudarmanto. 1996. Identifikasi asap cair dari berbagai jenis kayu dan tempurung kelapa. Jurmal Ilmu dan Teknologi Pangan 1: 15 – 24.

[16] Pranata, J., 2008. Pemanfaatan Sabut dan Tempurung Kelapa serta Cangkang Sawit untuk Pembuatan Asap Cair sebagai Pengawet Makanan Alami.<http://word-to pdf.abdio.com >. Diakses tanggal 15 April 2016.

[17] J.M. Lingbeck, et all. 2014. Functionality of liquid smoke as an all-natural antimicrobial in food preservation. Meat Science Journal, 97: 197-206

[18] Z. Alcicek, M.O. Balaban. 2016. Characterization of Green Shelled Mussel Meat. Part I: Quantification of Color Changes During Brining and Liquid Smoke Application Using Image Analysis. Journal of Aquatic Food Product Technology, 24:2–14

[19] S. Saloko, et all. 2014. Antioxidative and antimicrobial activities of liquid smoke nanocapsules using chitosan and maltodextrin and its application on tuna fish preservation. Food Bioscience Jurnal, 7: 71-79

[20] S. Yuningsih, S.P.A Anggraini. 2013. Characterization of Liquid Smoke from Coconut Shell to Be Applicated as Safe Food Preservatives for Human Health. Journal of Agriculture and Food Technology, 3(2)1-5, 2013

[21] K.R. Smith, et al. 2000. Indoor Air Pollution in Developing Countries and Acute Lower Respiratory Infections in Children. Thorax 2000;55:518-532 (thorax.bmj.com diupload 31 Oktober 2012).

[22] Kilabuko, J.H. and Satoshi Nakai (2007). Effect of cooking fuels on acute respiratory infections in children in Tanzania. International Journal Environment Research Public Health, 4(4):283-288.

[23] Kilinc, B., Cakh, S. 2012. Growth of Listeria monocytogenes as affected by thermal treatment of rainbow trout fillets prepared with liquid smoke. Turkish Journal of Fisheries and Aquatic Science 12: 285-290.

[24] Sukar, dkk. (1994). Pengaruh kualitas lingkungan dalam ruangan terhadap penyakit ispa-pneumonia di Indramayu-Jawa Barat 1993/1994. Pusat Penelitian Ekologi Kesehatan Badan Penelitian dan Pengembangan Kesehatan, Jakarta.