Advanced Materials Research Vol. 845 (2014) pp 494-498
Online available since 2013/Dec/04 at www.scientific.net

doi:10.4028/www.scientific.net/AMR.845.494

The Utilization Potential of Rice Husk as an Alternative Energy Source for Power Plants in Indonesia

Muhammad Anshar[1,a], Ab Saman Kader[2,b] and Farid Nasir Ani[1,c]

[1]Department of Thermodynamics and Fluid Mechanics, Faculty of Mechanical Engineering, Universiti Teknologi Malaysia, 81310 Skudai, Johor, Malaysia.

[2]Marine Technology Centre, Faculty of Mechanical Engineering, Universiti Teknologi Malaysia, 81310 Skudai, Johor, Malaysia.

[a]M.Anshar60@yahoo.com, [b]abdsaman@fkm.utm.my, [c]farid@fkm.utm.my

Keywords: Rice husk, Potential energy, Alternative energy source, Power plant.

Abstract. The utilization of rice husk as an alternative fuel for the power plant in Indonesia is still under study. In present, steam power plants in Indonesia are still using coal fuel. This study was conducted to obtain data on the development potential of rice husk within 12 years duration. The potential of rice husk for each province was obtained by analyzing the rice production of 22 provinces that have rice production greater than 1 million tons per year. The study shows that the potential of rice husk and potential electrical energy increased by about 36.8% within 12 years or an average increase of around 3.1% per year. For the potential of rice husk in 22 provinces, the total gain was estimated 12.76×10^6 tons which is equivalent to 6.62×10^6 tons of coal or equivalent to 3.68×10^6 tons of oil. The available capacity of power plants is around 5,664 MW with the potential of electric energy is around 49,622 GWh. This potential is equivalent to 50% of the energy needs of coal in Indonesia in 2011, which was about 99,312 GWh. In conclusion, rice husk is indeed potential to be used as an alternative fuel in power plants thanks to its increasing yearly production and ability for distribution to all provinces in Indonesia.

Introduction

Indonesia is a rice producing countries ranked third in the world after China and India [1]. However, Indonesia still faces shortage of electrical energy, in which the electrification ratio is still low, especially outside Java. In rural areas, there are still many people who do not receive electricity supply and urban areas still experience frequent blackouts. These are due to lack of power production and the available power plants are unable to serve the needs of society and industry developments. More than half of the energy needs of Indonesia's electricity come from coal. Coal reserves in Indonesia are still a lot, but when consumed on a large scale, they would be out in no time. In addition, the use of coal as a fuel can harm the environment, starting at the time of mining to combustion [2]. Utilizing rice husks is a novel idea to be optimally utilized as fuel. Currently, rice husk is only discarded as waste that pollutes the environment. To overcome these problems, one alternative that can be done is to utilize the potential of rice husk as fuel in power plants optimally. Thus, it can reduce the use of coal and reduce environmental impact.

This study was conducted to obtain data on the potential energy of rice husk in Indonesia as an alternative fuel in power plants. Optimal utilization of rice husk can be one method to overcome the problem of shortage of electric energy and reduce the use of coal at power plants in Indonesia.

Materials and Methods

In this study, the analysis samples of the potential of rice husk were produced from year 2001-2012. 22 provinces were selected as samples locations as they produce rice more than 1 million tons per year, as presented in Table 2. These provinces represented 33 provinces in Indonesia. The data used was the statistical data of rice production in Indonesia in 2001-2011 (BPS-Statistics Indonesia, 2013). The method of analysis was done with reference to the literature and the results from previous studies.

Results and Discussion

Energy potential of rice husk. The potential of rice husk (RH) based on rice production (PP) was firstly generated. Each rice production generated 20% RH with a calorific value = 14 MJ/kg [3]. Thus, the following equation was obtained:

$$RH = 0.2 \times PP \quad (1)$$

Meanwhile, the potential energy of rice husk (EP_{RH}) and electric potential energy (EE_{RH}) was obtained by using the equation:

$$EP_{RH} = W_{RH} \times CV_{RH} \quad (2)$$
$$EE_{RH} = EP_{RH} \div f_C \quad (3)$$

where W_{RH} = number of rice husk, CV_{RH} = calorific value of rice husk, and f_C = conversion factor of joules to watt-hours. The potential capacity of the power plant (EC_{RH}) that produced can be obtained by using the equation:

$$EC_{RH} = EE_{RH} \div F_{EC} \quad (4)$$

where F_{EC} = conversion factor to obtain electrical power.

The economic potential of utilization of rice husk as fuel. The economic potential of utilization rice husk as fuel in the power plant can be obtained by converting the energy value of rice husk into coal or oil with reference to the calorific value of each. The equivalent value of rice husk with coal (Eq_{Coal}) or the equivalent value rice husk with oil (Eq_{Oil}), can be determined by using the equation:

$$E_{Coal} = EP_{RH} \div CV_{Coal} \quad (5)$$
$$E_{Oil} = EP_{RH} \div CV_{Oil} \quad (6)$$

where CV_{Coal} = calorific value of coal is about 27 MJ/kg [4], CV_{Oil} = calorific value of oil is around 48.5 MJ/kg [5]. By using Eq. 1 to Eq.6, data development potential of rice husk in Indonesia in 2001-2012 was obtained, as presented in Table 1.

Table 1. Development of Rice Production in Indonesia in 2001-2012

No.	Year	PP [$\times 10^3$ton]	RH [$\times 10^3$ton]	Eq_{Coal} [$\times 10^3$ton]	Eq_{Oil} [$\times 10^3$ton]	EP_{RH} [TJ]	EE_{RH} [GWh]	EC_{RH} [GW]
1	2001	50,461	10,092	5,233	2,913	141,289	39,247	4,480
2	2002	51,379	10,276	5,328	2,966	143,863	39,962	4,562
3	2003	52,138	10,428	5,407	3,010	145,984	40,551	4,629
4	2004	54,089	10,818	5,609	3,132	151,448	42,069	4,802
5	2005	54,155	10,831	5,616	3,127	151,636	42,121	4,808
6	2006	54,455	10,891	5,647	3,144	152,474	42,354	4,835
7	2007	57,157	11,432	5,928	3,300	160,042	44,456	5,075
8	2008	60,326	12,065	6,256	3,483	168,912	46,920	5,356
9	2009	64,399	12,880	6,679	3,718	180,317	50,088	5,718
10	2010	66,469	13294	6,893	3,837	186,113	51,698	5,902
11	2011	65,757	13,151	6,819	3,796	184,118	51,144	5,838
12	2012	69,045	13,809	7,160	3,986	193,327	53,702	6,130

In Table 1, it appears that for 12 years, the production of rice increased significantly each year, except in year 2011 which shows decrease around 1.1%, but then increased to around 5% in 2012. In general, the potential of RH and other important parameters increases each year. Over the last 12

years (2001 – 2012), the potential has increased amounted to approximately 36.8% within 12 years, or an average increase of around 3.1% per year, as shown in Fig.1.

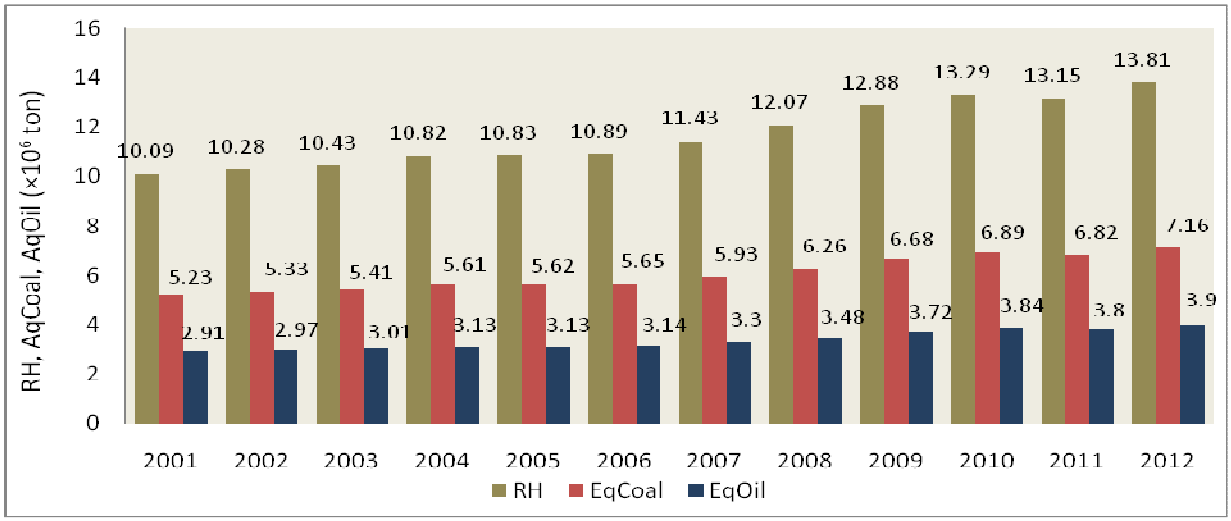

Fig. 1. Relationship of equivalent between rice husk with coal and oil.

The potential of rice husk in each province in indonesia. The potential of RH available for each province depends on generated PP. Eq. 1 to Eq.6 were used to estimate the potential for the development of rice husk in Indonesia from 2001 to 2012. In total obtained RH was around 12.76 $\times 10^6$ tons, equivalent to coal (Eq_{Coal}) around 6.616 $\times$ 10^6 tons, or equivalent to oil (Eq_{Oil}) around 3.683 $\times$ 10^6 tons, equivalent to electric energy potential (EE_{RH}) around 49,622 GWh, and equivalent to electrical power available (EC_{RH}) about 5,664 MW, as presented in Table 2.

Table 2. Energy Potential of Rice Husk for each Province in Indonesia in 2011.

No.	Province	PP [$\times 10^3$ton]	RH [$\times 10^3$ton]	Eq_{Coal} [$\times 10^3$ton]	Eq_{Oil} [$\times 10^3$ton]	EE_{RH} [GWh]	EC_{RH} [MW]
1	Jawa Barat	11,634	2,327	1,207	672	9,049	1,033
2	Jawa Timur	10,577	2,115	1,097	611	8,226	939
3	Jawa Tengah	9,392	1,878	974	542	7,305	834
4	Sulawesi Selatan	4,511	902	468	261	3,509	401
5	Sumatera Utara	3,607	721	374	208	2,806	320
6	Sumatera Selatan	3,382	676	351	195	2,630	300
7	Lampung	2,941	588	305	170	2,287	261
8	Sumatera Barat	2,279	456	236	132	1,773	202
9	Nusatenggara Barat	2,067	413	214	119	1,608	184
10	Kalimantan Selatan	2,038	408	211	118	1,585	181
11	Banten	1,950	390	202	113	1,516	173
12	Aceh	1,773	355	184	102	1,379	157
13	Kalimantan Barat	1,374	275	143	79	1,069	122
14	Sulawesi Tengah	1,039	208	108	60	808	92
15	Bali	858	172	89	50	668	76
16	DI Yogyakarta	843	169	87	49	656	75
17	Jambi	647	129	67	37	503	57
18	Kalimantan Tengah	611	122	63	35	476	54
19	Sulawesi Utara	596	119	62	34	464	53
20	NusatenggaraTimur	591	118	61	34	460	53
21	Kalimantan Timur	554	111	57	32	431	49
22	Riau	536	107	56	31	417	48
	Total	63,800	12,760	6,616	3,683	49,622	5,664

The energy potential of rice husk obtained from 22 provinces was around 49,622 GWh, equivalent to 50% of energy needs from coal in the year 2011 which reached 99,312 GWh [6], as shown in Fig.2. The projected use of coal as a primary energy source significantly increases each year, as presented in Fig. 3.

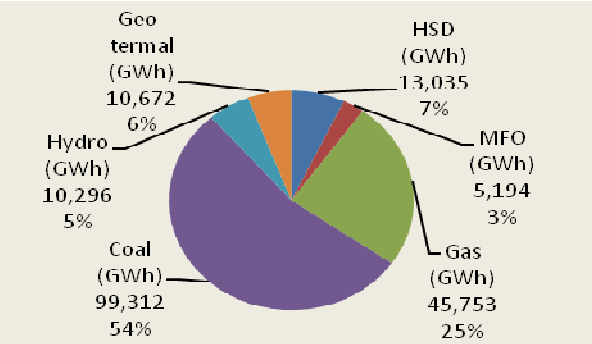

Fig. 2. Percentage use of coal in 2011

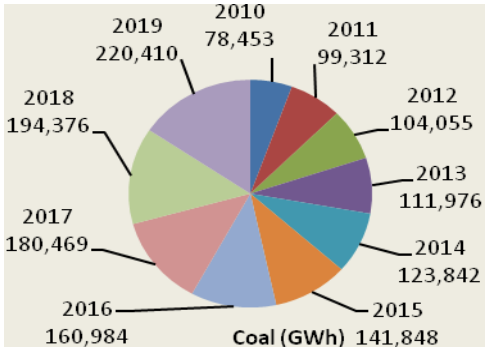

Fig. 3. Projected use of coal in 2010-2019

Fig. 3 shows the estimation of energy consumption of coal within 10 years (2010-2019), which would increase by about 141,957 GWh (181%), or averagely increase of about 18% per year. The use of coal in Indonesia is about 54%, greater than the standard use of coal in developing countries, developed countries, and the world, which only account for about 26-47% [7]. In anticipation of this, one of the alternatives is to optimally use rice husk as fuel in power plants, so as to reduce the excessive use of coal.

The utilization of rice husk as fuel at power plant. RH utilization as fuel in a power plant in Indonesia is still under study. Based on the data from the year 2011, Indonesia has a great potential of rice husk of about 13.151×10^6 tons with electric energy potential of around 51,144 GWh. This potential can be combined for fuel co-combustion with coal or other fuels, similar in Thailand [8] or mono-combustion in power plants like in India[9].

Conclusions

Utilization of rice husk as an alternative fuel in the power plant in Indonesia is still under study. The study shows that the energy potential, economic potential, and the potential for electric energy produced rice husk increased by about 36.8% during 12 years or averagely increases around 3.1% per year. The potential of rice husk in 22 provinces has the total gain of 12.76×10^6 tons/year which is equivalent to 6.62×10^6 tons of coal or equivalent to 3.68×10^6 tons of oil. The potential capacity that the power plant can produce is around 5,664 MW with around 49,622 GWh of electric energy. This potential is equivalent to 50% of the energy needs from coal in Indonesia in 2011, which is about 99,312 GWh. In conclusion, rice husk in Indonesia indeed has a great potential as a source of energy, as it increases every year, plus the energy can be distributed to all provinces in Indonesia. Rice husk can be utilized optimally as fuel for power plant in each province, besides reducing the use of coal and it can cope with environmental impact.

Acknowledgment

The authors are grateful to the Marine Technology Centre (MTC) for the financial assistance from project vote A.J090802.5550.07132 for the conference fees.

References

[1] Rahman, A. and J. Harris, Rice Husk Power Project in Thailand Invested by Japanese Company. 2003.
[2] Dumaizone, Greenpeace Ingatkan Bahaya Energi Batubara, http://www.dumaizone.com /warta.php?act=full&id=867. 2010.
[3] Ahiduzzaman, M., Rice Husk Energy Technologies in Bangladesh, Agricultural Engineering International: the CIGR Ejournal. 9 (2007) 1-10.
[4] United Nations Environment Programme, Converting Waste Plastics into A Resource, Compendium of Technologies. 2009.
[5] Environmental and Plastic Industry Council, A Review of the Options for the Thermal Treatment of Plastics, Environment and Plastics Industry Council (EPIC). 2004.
[6] PT PLN, Power Supply Business Plan PT PLN (Persero) 2010-2019, Indonesia. 2010.
[7] Jain, S. and M.P. Sharma, Power generation from MSW of Haridwar city: A feasibility study, Renewable and Sustainable Energy Reviews. 15 (2011) 69-90.
[8] Madhiyanon, T., P. Sathitruangsak, and S. Soponronnarit, Co-combustion of rice husk with coal in a cyclonic fluidized-bed combustor (ψ-FBC), Fuel. 88 (2009) 132-138.
[9] Kapur, T., T.C. Kandpal, and H.P. Garg, Electricity generation from rice husk in Indian rice mills: Potential and financial viability, Biomass and Bioenergy. 10 (1996) 393-403.

Materials, Industrial, and Manufacturing Engineering Research Advances 1.1
10.4028/www.scientific.net/AMR.845

The Utilization Potential of Rice Husk as an Alternative Energy Source for Power Plants in Indonesia
10.4028/www.scientific.net/AMR.845.494

DOI References

[7] Jain, S. and M.P. Sharma, Power generation from MSW of Haridwar city: A feasibility study, Renewable and Sustainable Energy Reviews. 15 (2011) 69-90.
http://dx.doi.org/10.1016/j.rser.2010.09.007
[8] Madhiyanon, T., P. Sathitruangsak, and S. Soponronnarit, Co-combustion of rice husk with coal in a cyclonic fluidized-bed combustor (ψ-FBC), Fuel. 88 (2009) 132-138.
http://dx.doi.org/10.1016/j.fuel.2008.08.008
[9] Kapur, T., T.C. Kandpal, and H.P. Garg, Electricity generation from rice husk in Indian rice mills: Potential and financial viability, Biomass and Bioenergy. 10 (1996) 393-403.
http://dx.doi.org/10.1016/0961-9534(95)00116-6