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GASIFICATION OF COAL AS A SOURCE OF HEAT ON ALTERNATIVE OF CARBONATION PROCESS TO MAKE A LOCAL BRIQUETTE

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ABSTRACT

The aims of the research work described in this paper is to find out an alternative source of heat in carbonation process to make local briquettes using cheaper fuel by mean of heat generated from the combustion gases of coal gasification. The research was initiated from collecting raw materials which has a low calorific value. Initially, coal was dried to make a maximum moisture content up to 12 % and form the coal at size of 10 cm. Further process were filling the vertical downdraft gasifier as much as 6 kg of coal, burned it with liquid petroleum gas (LPG) as ignitier, turn on the blower with the maximum speed in order to find combustion process. After that, all coal in the surface of gasifier have been burned, attach the burner and then count the velocity of air that was produced by blower as parameters to obtain the optimal velocty in order to get the perfect combustion. The result showed that the coal gasification technology with vertical downdraft gasifier system is promising to be developed as a source of heat in the process of carbonation of local coal briquettes. Using 6 kg of coal gasification can produce temperature at furnace carbonation around 170 ^{o}C as long as 60 mim with local kokas-briquettes that are carbonated at 10 kg.

Keywords: local coal briquettes, gasification, vertical downdraft gasifier, coal.

INTRODUCTION

Metal casting is a business that has a relationship with other businesses. However, many obstacles were encountered in developing such of business. The biggest issue in line with business is the high cost and scarcity of raw materials such as scrap metal followed by increasingly expensive fuel briquettes main in the form of coal. Several attempts to overcome this problem, especially in terms of fuel supply has been offered, one of which is felt appropriate alternative is to switch from technology of cupola foundry with induction, however, due to the government's policy to raise the electricity cost , the entrepreneur began to think back to use technology cupola. Cupola on the casting process is done by burning together the raw materials of scrapped metal with coal as fuel. One obstacle in the use of technology cupola is considerable energy costly, fuel come from coal that is used to import. One effort to overcome this is by introducing local coal briquettes, local coal briquettes where raw materials are local solid waste from the processing of petroleum.

Kokas briquettes are an important component as fuel to metal melting in the metal casting process that uses cupola system. Mechanical strength and good capability to burn of briquettes is a parameter that determines the success of the metal melting process.

Optimization of strength of mechanical and characteristics of kokas briquettes are determined by several factors, for example operating conditions of the kokas briquettes. In the carbonation process of the volatile content of kokas briquettes will be minimized in order to strengthen the bond of briquettes. Carbonation is one of the important processes in the manufacture of briquettes, but this process also need high cost, since the heat required in the process of carbonation is quite high and always continuous. On the other hand, businessmen always want production of kokas briquette at low cost, so, it will be more competitive when it is compared with electricity uses. Therefore alternative heat source is needed in the process of carbonation. Hot Gasses that come from the combustion of coal on gasification process is one of the alternatives, as the price of coal is quite low, around 1000.00 IDR/kg and have high calorific values.

Briquette-making process as local coal can be described that the coal as raw material to be destroyed roughly one particular particle size, then pressed by using adhesive, raw coal briquettes that so must undergo carbonation process to raise the calorific value and to strengthen the bonds of briquettes. Carbonation process plays an important role in producing mechanically strong briquettes and having good combustion characteristics, some carbonation process is an important parameter are the temperature at the end of the carbonation process, temperature and rate of rise of temperature in the long detention carbonation process, the combination of these three parameters will local produce coal briquettes which can be used as a basic material in the metal casting process.

In the process of carbonation coal briquettes needed local source of heat that can be controlled for a long time and cheap. Local coal briquettes carbonation process has been commonly carried out in one of the centers company in metal casting Ceper Klaten in Central Java is using diesel-fueled burner, certainty, this will make the energy cost of carbonation process less effective and costly, therefore, it need to find alternative sources of process heat the local carbonation coal briquettes using cheaper fuel and one of the solutions is to use the heat generated from the combustion gases of coal gasification.

Selection of coal, especially low calorific coal which generated a lot in Indonesia, as fuel coal briquettes local carbonation process is due to the price is cheaper than the price of diesel oil.

Theoretically, the process of gasification is the process of thermo - chemical conversion of solid biomass material into a gas. Gas produced during the gasification process consists of : (a) carbon monoxide, (b) hydrogen, (c) methane, (d) carbon dioxide, and (e) water vapor .

Reed *et al.* (2000) examined the issue of engineered wood furnace modified with gasification systems, and found that the addition of a blower with 3 W power would be able to produce 1-3 kW of power (heat) that can be used to cook with more than 30 % efficiency. Dassapa and Paul (2001) conducted research on coal gasification in basic packed and showed that a lot of heat losses occured at cooling conditions and found that the critical air flow rate to produce charcoal flame propagation in a maximum of about 0.1 kg/m2s. Kramreiler *et al.* (2008) examined the issue of biomass gasification to produce power 125 kW found that the rate of biomass gasification biomass is determined by particle size, moisture content of the biomass and the dominant factor to improve the efficiency of gasification is a variation of the air flow rate.

Pathak *et al.* (2008) examined the performer evaluation of down draft gasifier types of agricultural waste-fueled, it was found that the conversion to increasing gasification greater at higher temperatures required greater air flow.

Several study were carried out by the prominent researchers in investigating effect of pressure on oxidation rate of Millimetre-sized Char Perticles (Bateman, K.J. *et al.*, 1994, Belonio, A. T., 2005). For some cases, study referred to the theory of advanced combustion and gasification of fuel blend support to the research area (Borman, G. L., Ragland, K. W., 1998). In term of air fuel ratio (AFR) and its effect has also been investigated in conjuction of the formation of Nitrogen oxides (Hase, K., *et al.*, 1991). Ito, et. al. (1991), carried out the similar investigation related to the context.

There also a study of the mechanism of flame acceleration in a tube of constant cross section (Kemampran, S., et.al., 2000). In another context, Ismail, S. (1992) in their study, that some alternatives coal in Indonesia were reveals as an effort in diversification primay energy. Meanwhile, the varians of coals in supporting small industry in Indonesia was addressed in energy conference (Soedjoko, T. S. and Susilo, W., 1998). Whereas, quite recent study was carried out by Sudarno (2005), reveal a row of fins in reflector of heat radiation are able to increase efficiency of burner performance.

Based on the literature study conducted, it appears that the rate of air supply is one of the parameters in the gasification process, therefore, in this study conducted research on the effect of air inlet angle on the characteristics of coal gasification is addressed. The preliminary study of it was carried out by optimizing adhesive material (Wijianto *et al.*, 2015).

METHODOLOGY

Material

This Gasification proses use coal which has a low calorific value that is equal to 4253.03 cal/g with an average particle size of 10 cm. As for the local carbonated kokas briquettes are local kokas briquettes that are produced by a previous research of the research team.

Equipments

This research use vertical down draft gasifier type in 15 cm diameter, outer diameter of 20 cm and a height of reactor is 60 cm, as shown in Figure-1.a. Figure-1.b are vertical downdraft gasifier and furnace where the process of carbonation of local kokas coke briquettes occur with carbonation furnace capacity that equal to 10 kg.

Figure-1(a). Vertical downdraf gasifier.

Figure-1(b). Furnace.

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Data Collection Methods

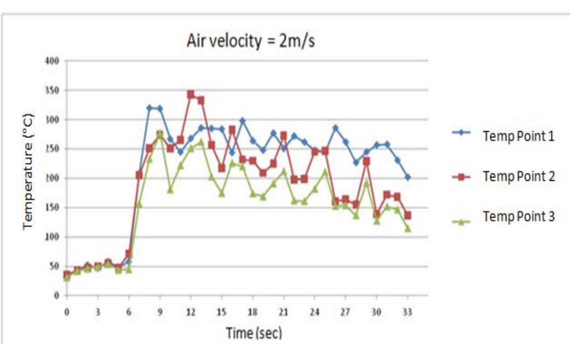
Research was started with the collection of raw material such as coal and local kokas briquettes accordance with the results of previous research. Coal was dried become maximum moisture content of 12 %, and make size of coal in average size of 10 cm.

Gasifier tube was filled coal until full, startup process with LPG gas as an Igniter, then turn on blower at top speed and igniter was turned on in order to combustion process occurs, once all coal on the surface of gasifier was burned, burner immediately mounted and lighted on in order to rise up a flame. Meanwhile, in the gasification furnace filled with local kokas briquettes with weight of 10 kg. The data from this research were the temperature distribution in the furnace of gasifier tube, which was at the bottom of a pile of local kokas briquettes, in the middle and in the upper of the local kokal briquettes, and was done using a thermocouple type K, the thermocouple was read using a reader in 5 minutes interval, the time data was retrieved by using a stopwatch. Weight data as well as the beginning and final of coal ash after burning was completed also noted. Air velocity in this gasification system was operated in 6 m/s.

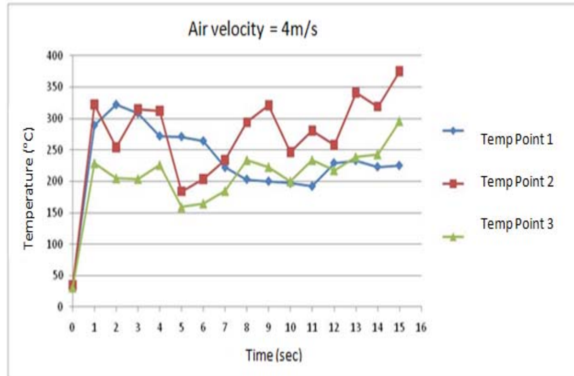
RESUTLS AND DISCUSSION

A series of data collected in a vary of air velocity resulting graphs showed in Figure-2a, 2b and 2c. The Figure-2.c present the graphs correlation between temperature of the flame produced in the coal gasification process with air velocity on the gasification process at 6 m/s. It is evedent that the greater speed of the maximum flame temperature generated is capable of 450 °C, but averages of the temperature of the flame of 300 °C revealed. And also seems that with higher air velocity then the shorter time at fire burning.

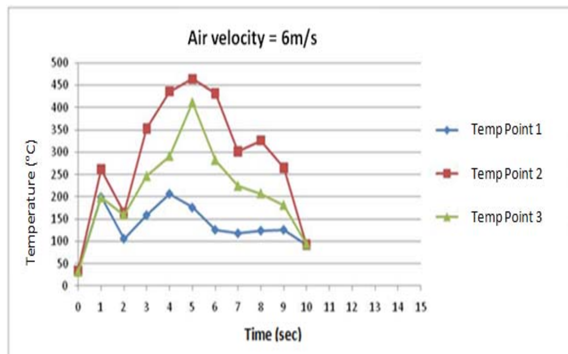
This is presumably because the gasifier designs used, the air velocity of 2 m/s is the speed that gives optimum Air Fuel Ratio (AFR) is right for gaseous reaction, it caused a gas formed more than other variables airspeed. Meanwhile from the graph, it appears that the higher air velocity, temperature the greater the resulting fire, it is presumably because with the rapid speed of the mixing of air between the gases and air gasification burner at the end of the good outcome so that the tip of the outer burner burning more perfect, so that the resulting flame temperatures are also getting bigger.



(a)



(b)



(c)

Figure-2. Comparison of temperature variation due to input angle air.

Temp Point 1 = 1 cm distance form the burner
Temp Point 2 = 2 cm distance form the burner
Temp Point 3 = 3 cm distance form the burner

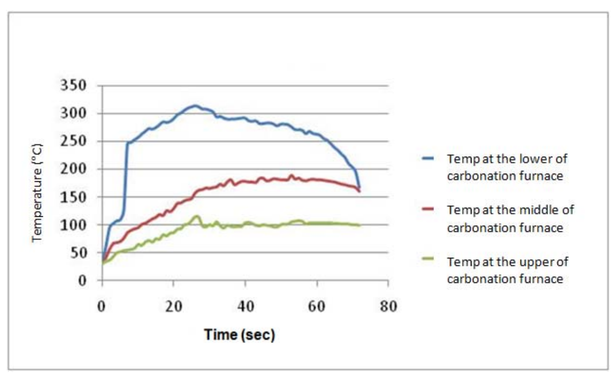


Figure-3. Temperature distribution in the furnace of carbonation of local kokas briquettes.

Figure-3 shows the temperature in the middle of gasification-furnace of local kokas briquettes around 175 ° C, and it is quite a big different when compared with the lower part of the furnace which can reach 275 °C. That is because the direction of the fire resulting from the combustion gases of coal gasification is in the horizontal direction so that waste a lot of spilled heat to the environment, so it needs a steering flame in order the heat can be focused in the gasification-furnace. From the study, it appears that the coal gasification process can be used as a source of heat in the carbonation process of local kokas briquettes, although it still requires further research, especially in terms of design for space ignition in the furnace carbonation.

OPPORTUNITIES OF GASIFICATION TECHNOLOGY USING LOCAL COAL BRIQUETTES IN CARBONATION PROCESS

By evaluating results discussed the above, the prospective coal gasification technology is used to subtitute diesel-fueled burner, it is mainly considered from an economic standpoint. The use of diesel as a fuel carbonation process around was normally 14 liters per batch, assuming that the price of diesel fuel remained in the range of 7.500.00 IDR is required fuel cost of 105.000.00 IDR/batch carbonation that produces about 150 kg of briquettes, while coal gasification technology is used when it is necessary only coal by 8 kg/batch carbonation and assuming coal prices ranging from 1000.00 IDR/kg then needed fuel cost 8000.00 IDR/batch carbonation that produces 150 kg of coke briquettes. Thus at least a component of fuel costs can be reduced, thats way as to make the production more competitive in competing.

CONCLUSIONS

The result showed that the coal gasification technology with vertical downdraft gasifier system have the prospect that might be developed as a source of heat in the process of carbonation local coal briquettes. Their fire temperatures capable to produced at the range of 150oC to 450 ^{o}C, for 10 to 30 minutes with the weight of coal used of 6 kg

The highest temperature was reached using the blower air at velocity 6 m/s, that mean that this temperature is very important to carbonation process to make local briquette.

Regarding kokas Briquette Local as alternative energy to substitute diesel fuel for carbonation process, kokas Briquette Local provide a huge economic efficiency, which is reach 76%.

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