MUDRA
ISSN 0854-2461

Volume 31, Number 3, September 2016
p 326 - 331

The Effect Of Sawdust Addition To Physical Body Of Kidul Clay Based Earthenware Ceramic

KOMANG NELLY SUNDARI

(Researcher at BPP TEKNOLOGI - BTIKK
(Agency for the Assessment and Application of Technology - Institute of Ceramics Creative Industrial Technology)
Jl By Pass Ngurah Rai Tanah Kilap Suwung Kauh Denpasar Bali, 80221
E-mail: komang.nelly@bppt.go.id

Telah dilakukan penelitian ”Pengaruh penambahan serbuk kayu terhadap sifat fisik bodi keramik earthenware berbasis clay Kidul” dengan persentase yang berbeda. Serbuk kayu yang digunakan adalah limbah serutan kayu bahan bangunan. Berdasarkan hasil analisa kimia diketahui serbuk kayu cenderung memiliki sifat sebagai bahan pelebur, sedangkan clay Kidul cukup mengandung clay substance/lempung, mineral feldspar dan mineral kuarsa. Penelitian ini bertujuan untuk mengetahui sifat-sifat fisik masa bodi yang terkomposisi, baik dalam keadaan prabakar dan pascabakar sebagai keramik earthenware. Benda keramik yang dihasilkan bisa dipergunakan sebagai wadah kebutuhan air tanaman dengan teknik perembesan. Jadi yang dicari adalah komposisi dengan nilai perembesan/penyerapan air/PA yang terbesar. Pengamatan sifat fisiknya dilakukan langkah-langkah penelitian skala laboratorium melalui uji bata-bata dan skala produksi melalui uji prototipe. Hasil yang dicapai sesuai dengan tujuan adalah massa bodi kode BG1 yang telah memenuhi syarat sebagai keramik earthenware pada suhu bakar 1.150oC dengan nilai PA=20,2% (SNI: 7275-2008, PA > 15% dikatagorikan sebagai gerabah halus lunak atau mayolika, sedangkan SII: 0803-83, PA > 20% dikatagorikan sebagai gerabah halus lunak dengan suhu bakar 1000oC). Namun masih perlu dilakukan penelitian lanjutan dengan penambahan bahan penolong serbuk kayu dengan persentase yang variatif selain pengujian dengan berbagai bentuk disain agar dari sisi estetika dan fungsinya sebagai benda keramik earthenware dikemudian hari menjadi lebih bermakna.

The research on "The Effect of the addition of sawdust on the physical properties of ceramic body of Kidul clay-based Earthenware " has been performed with different percentages. The sawdust used is wood shavings waste of building materials. Based on the results of chemical analysis, sawdust is known to have a tendency as a fuser, whereas Kidul clay contain enough clay substance / loam, feldspar and quartz minerals. This study aims to determine the physical properties of the composite body period, either in a state of pre-combustion and post-combustion as ceramics earthenware. The produced ceramic objects can be used as a container of crop water by permeation techniques. So what is sought is a composition with a value permeation / absorption of water / the greatest PA. To observe its physical properties, measures of laboratory scale study was conducted by testing the bricks and the scale of production through prototype test. The result is in accordance with the purpose that is the body mass of BG1 code that has been qualified as Earthenware ceramics at a fuel temperature of 1.150oC with a value PA = 20.2% (SNI: 7275-2008, PA> 15% categorized as soft delicate earthenware or mayolika, while SII: 0803-83, PA> 20% is categorized as smooth soft earthenware with fuel temperature of 1000oC). However, further research still needs to be done with the addition of an adjuvant sawdust with varied percentages in addition to testing with various forms of design in order that in terms of aesthetics and function the earthenware ceramic objects later become more meaningful.

Key words: Kidul clay, sawdust, earthenware, water absorption, shrinkage amount

Ceramics are objects made of materials with the composition of the silicate or oxide, non-oxide, or its mixtures with the glass structure that requires combustion at high temperatures above 570oC(2) in the manufacturing process.

For conventional ceramic, the manufacturing still involves clay / loam as one of its main raw materials. One of clay that will be examined as a body mass of earthenware ceramics is light colored rather beige Kidul clay / Kidul loam. Usually, the main ingredient of pottery / Earthenware is dark / brown clay. The feature of Kidul clay studied has the relative plastic nature and the color is beige to yellowish. This clay has not been widely used in the manufacture of traditional ceramics in the region of origin. As time passes and needs, the clays began to be considered for use as a raw material to be transformed into ceramic objects, but it should be mixed with other materials in advance to obtain ceramic raw materials with adesired quality.

The qualification of body earthenware ceramic must meet the standards, among others (7): have form water of 13-41%, in a wet state under conditioned from less plastic to plastic, made from a single material or mixed with other materials, the fuel temperature between 1000 - 1150oC,., dried shrinkage 7 - 8%, maximum fuel shrinkage 7%, maximum shrinkage of 17% and the amount of water absorption 10-15% with visual sightings opaque, not bent, has a smooth surface, color and clinking sound is not loud when the body is tapped.

According to the ISO: 7275-2008, the body mass of PA values > 15% are categorized as soft delicate earthenware or mayolika, while according to the SII: 0803-83, body mass PA values> 20% are categorized as soft smooth pottery with fuel temperature of 1000oC. The materials used such as Kidul Clay and sawdust contain ingredients among others;

- As the clay this material has the properties as a binder. Clays are composed of fine particles originating from the mineral under going the process of weathering due to the weather. This material is carried by wind or water flow and settle and become solid due to the influence of hydrothermal reaction or soil bacteria for years. As the binder, it has a high melting point (about 1740oC) and at the burning of clay will break down, the orienta tion of the particles is reduced quickly and collapses before solid (sintering). Some examples of materials that belong to the binder include (1) *ballclay, talc* and *bentonite*
- Quartz (SiO2) as a filler. Quartz is one of the silica mineral. Quartz is the refractory raw material of ceramic (melting point 1715oC), resistant to acid / alkaline and hard (4.5). This material is responsible in the power of the body mass, both before and after combustion. In a state of their own, silica is a dry powder that is not sticky and brittle in the formation and after formation. Quartz mineral generally have the formula of WZ4O8 with W is Na, K, Ca and Ba, while Z is Si and Al in the ratio of Si: Al varies between 3: 1 to 1: 1.
- Feldspar as fusing material is a material alkaline metal / earth alkaline. Feldspar melt ing point is approximately 1250oC (6). The presence of alkaline metal / earth alkaline in feldspar helps silicate and alumina to fuse and melt at a lower temperature. Feldspar fusion forms glass liquid that fills the pores of the body, affecting the smelting on fine particles, binding larger particles and playing a role as pasta that unites particles to become solid after cooling.
- Limestone in a certain amount that is mixed in the clay will make the infiltration water of ceramic body low (1).

Body mass is made with the intention to test its physical properties, both in state of pre-combustion and post-combustion as earthenware ceramics which will function as a container of water reservoir for watering plants with permeation system.

RESEARCH METHODS

1. Materials and Equipment

The materials used in this study is Kidul clay and wood (sawn wood waste). While the equipment used is a sieve with 2.00 mm diameter, mixer, wood molding tool, sliding ruler, testing tools, other tools and an electric furnace.

2. The composition design

Experiments were performed with the composition design (body mass) of 4 compositions (BG1, BG2,

BG3 and BG4)

Raw material	Composition (%)			
	BG1	BG2	BG3	BG4
Kidul Clay	86,70	92,88	96,30	94,22
Saw-dust	13,30	7,12	3,70	5,78

Table 1. Composition design

3. Research Procedure

The steps of research is as follows

a. All materials are weighed according to the percentage by weight in the composition

b. The materials are blended and mixed by adding sufficient water

c. The mud is put in the mixer to obtain a smooth dough / mixture

d. Then the sludge is filtered with a 2.00 mm sieve and then precipitated, the water is removed and the silt is put in the wind on the plaster container in order to obtain a body mass with moisture content of + 35%.

e. Massa is ready to be formed into test specimen / test brick.

f. The test bricks are burned at the desired temperature, that is 1150oC. Combustion is done using an electric furnace and conducted over + 8 hours.

g. The length of the given mark is measured, the measurement results are used to determine the amount of fuel shrinkage and shrinkage of amount.

h. The test bricks are measured / weighed

i. The weighed test bricks are immersed for one night

j. The volume of bricks that have been soaked (water saturated test bricks) are weighed and measured

The results of the required parameter measurement is calculated using standard formulas. The standard formulas used to calculate the body mass properties of the ceramic, are: fuel shrinkage, amount shrinkage, water infiltration, and pseudo pores as follows

Fuel shrinkage = (100x(pb-pk)/pb%

amount shrinkage = (100x(pb-pk)/pb%

water infiltration = (100x(bb-bk)/bk%

pseudo pores = (100x(bb-bk)/(bb-bda)%

In which :

pb : Length of tested brick burn (cm)

pk : Length of tested brick dry (cm)

bb : Weight of water saturated tested brick (gram)

bda : Weight in water (gram)

bk : dry weight (gram)

RESEARCH RESULT

1. Results of Chemical Analysis

The results of chemical analysis of earthenware raw materials studied from Kidul clay, Central Java and sawdust can be seen in Table 2.

chemical composition	Kidul Clay	Sawdust
SiO_2	50,71	0,50
Al_2O_3	19,10	-
Fe^2O^3	8,97	-
TiO_2	1,00	-
CaO	4,76	1,68
MgO	1,61	1,11
K_2O	0,73	0,56
Na_2O	1,93	0,87
HP	10,72	94,88

Table 2. Chemical Analysis of Raw Materials

The results of the chemical analysis followed by mineralogical analysis showed that Kidul clay contained enough clay / loam substance, feldspar mineral and quartz mineral, and the sawdust contained enough feldspar minerals functioning in the ceramic material as the buster

2. Results of Visual Observations

Visual observation is made to identify the occurrence of cracking or breaking on the surface of the specimen. Visual observation was done by seeing whether or not cracks in the tested specimen by

using a magnifying glass . The cracks that occur can be distinguished on the star cracks and hairline cracks. The star cracks show widening cracks towards the beginning of the crack with the blunt crack edge, while the hairline cracks showed a thin line cracks with sharp crack edges. Visual observation data of BG1 code, BG2, BG3 and BG4 at temperature of 1150oC are presented in Table 3. The cracks are presented quantitatively by using the following criteria:

- More than 10 : many
- Between 5-10 : moderate
- Less than 5 : little
- None : naught

Temperature	Composition			
	BG1	BG2	BG3	BG4
1150(^{o}C)	naught	naught	naught	naught

Table 3. Results of visual observation

From Table 3 above it can be seen that in the Kidul clay-based body mass of pottery / Earthenware and sawdust no signs of cracking either hairline cracks or star cracks are found

3. Results of Physical Test

Test on the physical properties of post-combustion was performed to determine whether a mass at a certain temperature has reached the desired density (sinter). A mass density is characterized by the value of water absorption (PA) it. If the value of PA has been equal or less than the standard set at a temperature of the fuel, the mass has sintered. PA value for Earthenware / pottery by SII: 0803-83 body mass with water absorption value (PA) achieved> 20% categorized as smooth soft earthenware with fuel temperatures up to 1000oC. But this study is aimed to obtain the highest value of the PA in order to achieve the greatest permeation that will be used as a water container to for watering plants with permeation techniques. In terms of temperature or combustion temperature to reach maturity as an Earthenware mass with maximum strength, then combustion was done with a maximum temperature of 1150oC.

The value of PA and pseudo pores (KS) are the image density and mechanical strength of the resulting ceramic body. PA and KS is a picture of the many open-air cavities (air voids in the ceramic body connected / penetrating outside air so that it can be filled with water when soaked) and a closed cavity (air cavity is not connected to outside air). If the value of PA and KS is high then the number of cavity will be more and more so that density will be small and power is small as well. The complete characteristics obtained can be seen in Table 4.

No	Tested Parameter	Fuel temperature 1150^{o}C				Standar Earthen-ware
		BG 1	BG 2	BG 3	BG 4	
1	Colour	rosy beige	rosy beige	rosy beige	rosy beige	colored
2	Sound	Not sonorous	Not sonorous	Not sonorous	Not sonorous	Not sonorous
3	Fuel shrinkage (%)	2,7	3,2	3,6	3,3	maximum 7
4	amount shrinkage (%)	8,8	9,1	10,4	10,1	maximum 17
5	water infiltration * (%)	20,2	18,4	18,3	18,9	maximum > 20
6	pseudo pores * (%)	38,41	33,14	31,48	33,07	-

Notes: An average of 10 times measurement

Table 4 Characteristics of Earthenware Body Mass based on Kidul Clay and Wood Sawdust at the Temperature of 1150oC and Referred Standard Values

At a fuel temperature of 1150oC the PA value of Earthenware based on Kidul clay and sawdust with BG1 code is the highest, 20.2% (in line with the research objectives to obtain the greatest permeation), and the combustion at the temperature of 1.150oC has made the Earthenware body a sintered / solid. From Table 4 it is seen that the more substitutes of sawdust, the smaller the amount shrinkage. For more details, the description of the relationship between the use of Kidul clay and sawdust can be seen in the following figure.

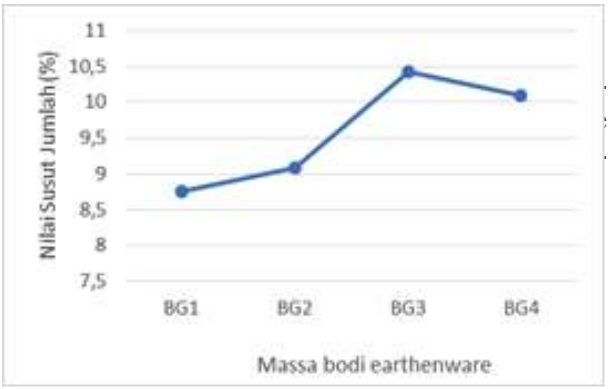

Figure 1. Graph of amount shringkage
Code BG1,BG2,BG3 and BG4

This is possibly due to the content of the lost incandescent (HP) on Kidul clay is 10.72%, and the chemical composition of the sawdust lost incandescent (HP) is also quite high 94.88%. The lost incandescent signals the presence of organic substances, impurities, and the water will evaporate at a temperature ranging 1000oC. Besides, the increasing substitution of sawdust used in the BG1 composition as the buster material increased so that the glass phase that is formed during the combustion reaction reduced resulting in the development of volume remained large, consequently decrease the amount shrinkage is getting smaller. Then the relationship between Kidul clay and sawdust to the value PA (water absorption) can be seen in the image below.

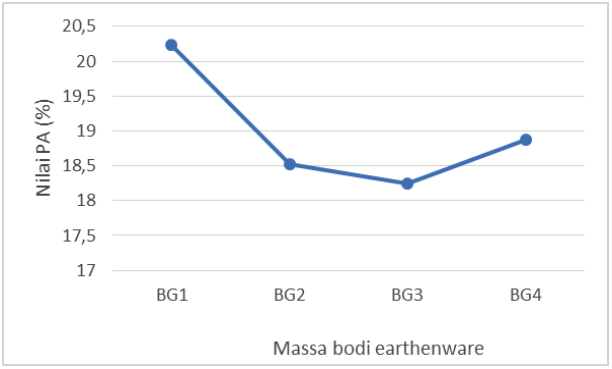

Figure 2. Graph of Water Absorption
code BG1,BG2,BG3 and BG4

From Table 4 and Figure 2 above it can be explained that more and more use of sawdust in the composition, the greater its PA value. This is because the formed glass phase during the combustion reaction is very limited so that the pores in the body are still open which makes the body still porous. The formation of glass phase depends on the amount of the fuser (K2O and Na2O) contained in the raw material and the combustion temperature. The higher the temperature of the combustion, the reaction of mullite formation of SiO2 and Al2O3 will be more increasing and more and ceramic body will be more dense

CONCLUSION

Based on the results obtained it can be concluded that:

- Judging from PA (water infiltration), Earthenware body mass with BG1 code has represented the largest permeation performance compared with other compositions (BG2, BG3, BG4).
- From the value of fuel shrinkage and amount shrinkage, the body mass of BG1 code qualifies as an eartenware mass body at a fuel temperature of 1.150oC
- Earthenware body mass of BG1 code is classified as Majolika.
- There were no star cracks or hairline cracks to be found

SUGGESTION

In this preliminary study the making of prototype object was conducted with the result that is in accordance with the purpose of research, but it is still necessary for testing / further research with the addition of an supporting material of sawdust with varied percentages in addition to the test with various forms of design in order that in terms of aesthetics and function as earthenware objects it will later become more meaningful

REFERENCES

Brian, 2001, *Panduan Praktis Kamus Keramik Untuk Praktisi*, Perajin dan Industri, Milenia Populer, Australia – Indonesia Institute, Jakarta.

Behrens, Richard, 1993, *Glaze Projects, a Formula of Leadless Glazes, A Ceramics Monthly Magazine Handbook*, Profesional Publications, Inc.,Ohio.

Frank Edwin dan Mulyana, 2005. *Pengaruh Penambahan Abu Sekam Padi Terhadap Sifat Fisik/Mekanik Keramik Hias Bodi Stoneware*,Jurnal Keramik Dan Gelas Indonesia, Departemen Perindustrian, Badan Penelitian Dan Pengembangan Industri Balai Besar Keramik Bandung, vol.14 No.1, juni 2005.

Nelson, Glen C., 1986, *Ceramics A Potterr's Handbook*, 5th. Ed., John Wiley and Sons, New York.

Oishi, *Ceramic Body*; Gifu Perfectural Ceramic Research Institut, Nagoya, International Training Center, Japan International Cooperation Agency.

Rhodes, Daniels, 1959, *Stoneware and Porcelain, The Art of High-Fired Pottery*, Chilton Book Company, Radnor, Pennsylvania.

Solichin Ardi, 1986. *Pengujian Bahan Mentah dan Produksi Keramik*, Balai Besar Penelitian dan Pengembangan Industri Keramik, Bandung.