World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:7, No:1, 2013

Kaolin for Production of Souvenirs

Ruedee Niyomrath

***Abstract*—**Ranong province has the best kaolin, and it is the most useful of all the clay types used in ceramic making. Until recently, there has been only one community business making ceramics in Ranong province. And this business could not build the mix of body and glaze from their raw material without assistance. Considering these problems, this research is aimed to test the composition of ceramic body and glaze which suit. Kaolin from Ranong is the raw material which these search focuses on. All other raw materials use in the investigation will come from southern Thailand, kaolin and limestone from Ranong province, ball clay from Surat Thani province, white sand from Songkhla province, and feldspar from Nakhon Si Thammarat province. Results can be used to develop the efficiency of industrial production which in return will enhance the business process.

***Keywords*—**Ceramic body and glaze, Ceramic material, Ceramic production from kaolin, Ceramic souvenirs.

I. Introduction

RANONG is a small province at the upper southern region of Thailand. The region has many mountains and is a place where Tin is found along with natural hot springs. There is a strategy to create jobs for the community and to promote tourism for health [1]. Health conscious Thai and foreigner tourists visit Ranong generating 1,000 million baht per year. A significant source of income and employment for the local economy, some of this income is derived from souvenirs. These souvenirs also have an additional benefit of being a perpetual advertisement in reminding tourists of their visit to Ranong.

Ranong not only has economic and social asset but is also rich in mineral resources. At the present, Ranong has the best white clay or kaolin, and it is used for ceramic work more than other types of white clay. Moreover, Ranong people do not promote this white clay to add value. There are many mines that export the kaolin to ceramic factories to all parts of Thailand. Until recently there is only community business to produce ceramic for souvenir. From this reason, the researcher now interested to develop to add more value to this type of clay from Ranong province.

The aims of this work were to test the composition of ceramic body and the glaze of the kaolin from Ranong. The other raw materials used in the investigation were from southern Thailand including ball clay from Surat Thani province, white sand from Songkhla province, feldspar from Nakhon Si Thammarat province, and limestone from Ranong province. Triaxial diagram was used for finding compositions of body and quadaxial diagram used for finding compositions of glaze. Results can be used to develop the efficiency of industrial production, which in return will enhance the business process.

Ruedee Niyomrath is with the faculty of Industrial Technology, Suan Sunandha Rajabhat University, Thailand (phone: 00662-160-1438; fax: 00662-160-1440; e-mail: treudee@gmail.com).

II. Research Objective

To test the composition of ceramic body and glaze that is best suited for the production of souvenirs.

III. Research Methodology

All raw materials used were the commercial grade from southern Thailand. Kaolin from Ranong province, ball clay from Surat Thani province, white sand from Songkhla province, feldspar from Nakhon Si Thammarat province, and limestone from Ranong province. The ceramic body and glaze were investigated in laboratory experiments.

A. Test of Ceramic Body

Triaxial diagram (Fig. 1.) was used for finding thirty six compositions of the ceramic body; these came from four materials, which were kaolin from Ranong province, white sand from Songkhla province, feldspar from Nakhon Si Thammarat province, and ball clay from Surat Thani province.

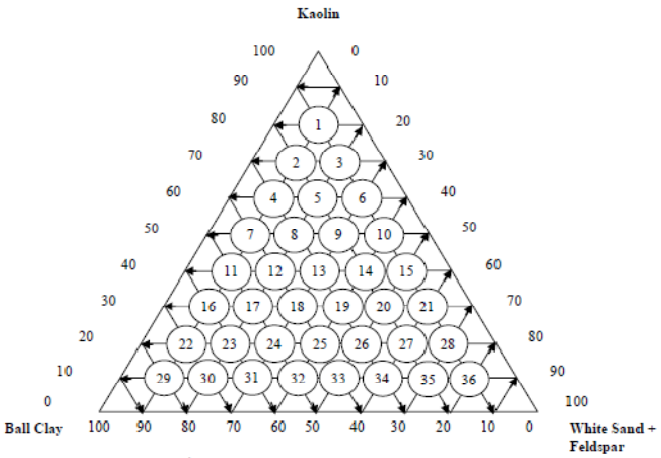

Fig. 1 Triaxial diagram used for finding the composition of ceramic body

Specification test of body compositions were the characteristic of slip body, drying behavior, and firing properties.

1) Characteristic of slip body by finding the specific gravity, deflocculates, and cast of rate at 5 minutes and 10 minutes were calculated by the following equations

Specific Gravity = Density of Slip / Density of Water (1)

% Deflocculation = (Density of Deflocculating / Weight of Dry Body) x 100 (2)

2) The drying behavior was described in term of linear shrinkage. The dried samples determined by the following equation [2]

% Drying Shrinkage = [(Plastic Length - Dry Length) / Plastic Length] x 100 (3)

The firing properties at 1,230 degrees Celsius, oxidation firing was described in terms of linear shrinkage, water absorption, and color. For the linear shrinkage, fired samples were determined by the following equations

% Firing Shrinkage = [(Dry Length - Fired Length) / Dry Length] x 100 (4)

% Total Shrinkage = [(Plastic Length - Fired Length) / Plastic Length] x 100 (5)

Water absorption after firing at 1,230 degree Conscious was calculated as:

% Water Absorption = [(Wet Weight - Dry Weight) / Dry Weight] x 100 (6)

The color of the bodies fired at 1,230 degrees Celsius were measured and classified in terms of L*, a*, and b* parameters from the CIE Lab system. Then the best body composition was selected and tested with suitable glaze.

B. Test of Ceramic Glaze

Thirty six glaze compositions were designed by a quadaxial diagram from four types of material include kaolin from Ranong province, white sand from Songkhla province, Feldspar from Nakhon Si Thammarat province, and limestone from Ranong province. Zinc oxide was used as an additional material which shown in Fig. 2.

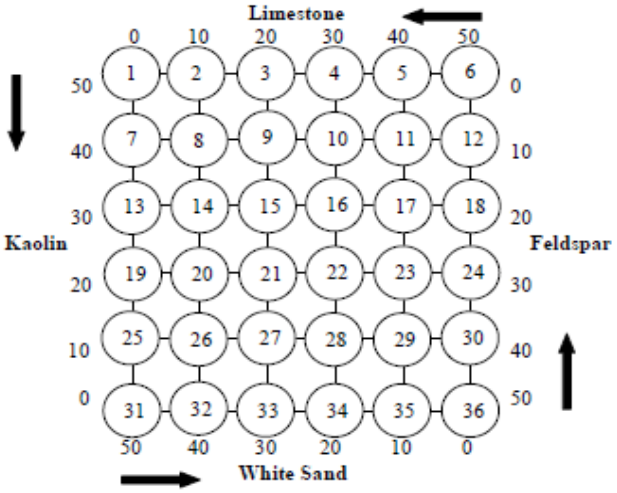

Fig. 2 Quadaxial diagram used for finding the composition of ceramic glaze

The electric furnace was fired at 1,230 degrees Celsius, oxidation firing. After firing, the best body composition and glaze compositions were discussed in term of color and suitability with the ceramic body.

For the suitability with the ceramic body, the considerations involved were the characteristic of surface glaze (gloss, semi matt, matt), transparency of glaze (clear, opacity), and glaze defects.

C. Research Stage

1)Specification of body composition used a triaxial diagram with 36 in measurements.

2)Test of body composition were the characteristic test of clay slip by finding specific gravity, deflocculated, and rate of cast, the drying test to find the characteristic by drying shrinkage test, and testing after bake at 1,230 degrees Celsius, oxidation firing testing by firing shrinkage, water absorption, and color.

3)The selected best body composition was tested to find the best suited glaze.

4)Testing to found the composition of glaze that was suited with the body by using quadaxial diagram in 36 mixtures.

5)Tested the characteristic of glaze after baking at 1,230 degrees Celsius, oxidation firing.

6)Selected the suitability of glaze composition for the ceramic body.

IV. Research Result

A. Ceramic Body

Test results found that 36 compositions of clay mix with water as the mixture in forming a body at 40 to 50%, specific gravity from 1.60 to 1.70, deflocculates at 0.17 to 0.37%, rate of cast at 5 minutes between 0.20 to 1.10 centimeter, and the rate of cast at 10 minutes between 0.30 to 1.40 centimeter shown in Fig. 3.

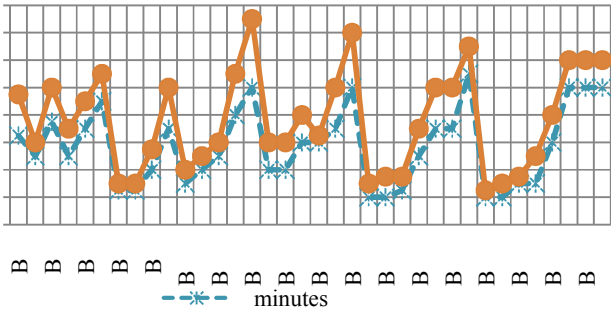

Fig. 3 Rate of cast at 5 minutes and 10 minutes

The test of dried characteristics found 17 mixtures with a drying linear shrinkage between 1.29 to 5.31%, firing linear shrinkage at 1,230 degrees Celsius in oxidation firing found to have about 4.97 to 6.45 %, total of linear shrinkage between 6.85 to 11.17% (Fig. 4), water absorption about 4.96 to 17.96% (Fig. 5).

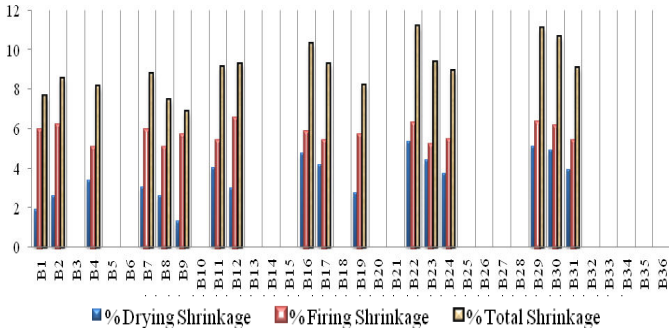

Fig. 4 Linear shrinkage of ceramic body

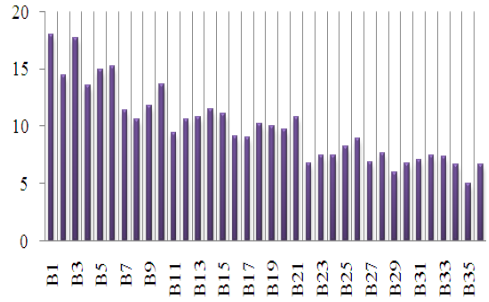

Fig. 5 Water absorption of ceramic body after being fired at 1,230 degrees Celsius

The ceramic bodies after being fired at 1,230 degrees Celsius had a very white near to cream color (Fig. 6). A colorimeter found the brightness (L*) to be between 84.36 and 92.51, having a comparison value between red and green (a*) at 1.02 to 2.45, and a comparison value of yellow and blue (b*) from 5.25 to 14.38 which is shown in TABLE I.

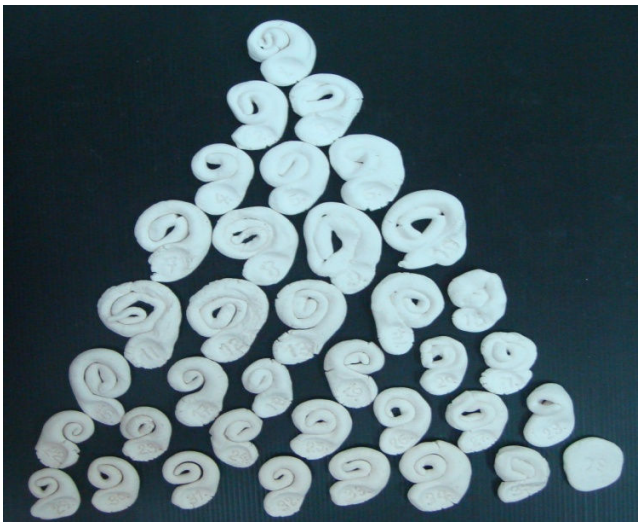

Fig. 6 Color of ceramic body after being fired at 1,230 degrees Celsius

TABLE I
COLOR OF CERAMIC BODY BY USING CIE COLORIMETRIC SYSTEMS

No.	L*	a*	b*	No.	L*	a*	b*
B1	92.51	1.25	5.31	B19	89.23	1.29	9.32
B2	91.67	1.32	5.62	B20	89.31	1.27	8.6
B3	92.39	1.1	5.25	B21	89.87	1.24	7.62
B4	91.25	1.31	6.5	B22	87.04	2.02	12.48
B5	91.79	1.16	6.29	B23	86.98	1.86	11.97
B6	92.41	1.02	5.83	B24	87.48	1.5	11.94
B7	88.78	1.67	8.33	B25	88.21	1.37	10.93
B8	89.65	1.39	7.39	B26	88.56	1.45	9.76
B9	90.28	1.28	7.38	B27	87.56	1.31	9.34
B10	91.64	1.09	6.45	B28	88.08	1.31	8.26
B11	88.93	1.65	8.59	B29	85.19	2.45	13.57
B12	89.74	1.45	8.85	B30	85.55	2.13	14.38
B13	89.04	1.2	9.22	B31	86.4	1.77	13.37
B14	90.58	1.13	7.6	B32	85.7	1.68	12.33
B15	90.45	1.19	7.01	B33	86.43	1.55	12.18
B16	88.67	1.78	9.82	B34	85.75	1.49	11.35
B17	89.01	1.52	9.71	B35	84.36	1.49	10.39
B18	89.16	1.35	9.16	B36	85.88	1.2	8.08

Finally, one formula was chosen with the composition of kaolin (Ranong) 70%, ball clay (Surat Thani) 20%, white sand (Songkhla) 5%, and feldspar (Nakhon Si Thammarat) 5%. This mixture used 42.50% water for the making of slip body which had a specific gravity of 1.67, deflocculates (Sodium Silicate) were 0.30%, rate of cast at 5 minutes equal to 0.5 centimeter, and 0.6 centimeter at 10 minutes. Characteristics of the body when dried and after fired at 1,230 degrees Celsius in oxidation firing found to had drying linear shrinkage at 2.58%, frying linear shrinkage equal to 6.11%, total linear shrinkage was 8.53%, white body, and water absorption was 14.44%

B.Ceramic Glaze

The results of suitable compositions after being fired at 1,230 degrees Celsius in an oxidation atmosphere, found that the glazes were white color in 15 formulas, cream color total in 6 formulas, very white total in 5 formulas, white color 5 formulas, and yellow in 5 formulas. The surface of glaze was found to be matt glaze in 21 formulas, gloss glaze in 5 formulas, and semi matt glaze in 10 formulas shown in Fig. 7.

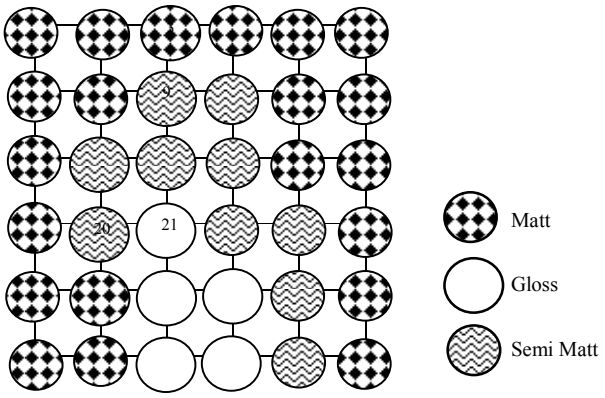

Fig. 7 The surface of glaze after being fired at 1,230 degrees Celsius

Clear glaze occurred in 11 formulas and opacity occurred in 25 formulas shown in Fig. 8.

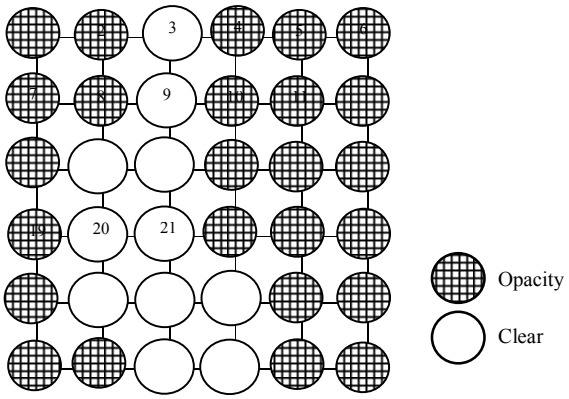

Fig. 8 The transparency of glaze after being fired at 1,230 degrees Celsius

The defects of the glaze included crazing, pinholes, peeling, and crawling.

The selected glaze composition of formula 27 (Fig. 9) has characteristics of clear glaze, gloss and shiny with crackle glaze and pinholes lightly. This mixture was kaolin 10%, feldspar 40%, white sand 30%, limestone 20%, and Zinc oxide 10% used as additional material.

Fig. 9 The glaze composition formula 27

V. Research Discussion

The test result found that the clay body composition after being fired at 1,230 degrees Celsius in an oxidation atmosphere had an absorption between 4.96 and 17.96 percent clay bodies with this absorption are categorized as white earthenware. This finding agrees with Pimpawan Wattanopas [3], Khomol Rugsawong [4], Grebanier [5], and Norton [6]; all the above used four types of main material. The find characteristics after being fired are caused from different material, different composition, and different firing temperature. Therefore, this test composition can be the stoneware body by suggest a firing at the higher temperature such as between 1,250 and 1,280 degrees Celsius.

For some reason, some item are better suited with matt glaze or semi matt glaze. Therefore the composition of formula 3 can be selected for white matt glaze, yellow matt glaze formula 17, semi matt glaze formula 20, and the crawling glaze formula 29. All glaze formulas can be used to decorate the ceramic items as shown in Fig. 10.

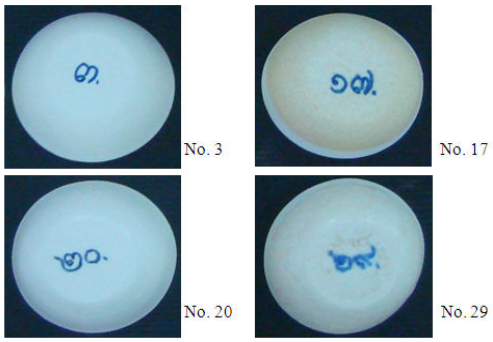

Fig. 10 Glaze formulas can be used to decorate the souvenir

The tested compositions of glaze were mature and every shine had 20 percent kaolin, feldspar mostly 30 percent. In the case of kaolin and feldspar less than 20 percent, the glaze was matt like. This was due to feldspar can decrease the temperature (fluxing agent) and kaolin are refractory. In addition, feldspar can be the source to create a cracked glaze. Specifically feldspar from Nakhon Si Thammarat province is soda feldspar. It has melting point lower temperature than potash feldspar. This problem is solved by adjusting the composition of glaze or adjusting both composition of glaze and clay body.

VI. Recommendation

A. Suggestion for Research Use

1)To make a coffee cup or food container a higher temperature needs to be used or an adjustment to the mixture using the quadaxial diagram to decrease water absorption.

2)In order to use color glaze, the body composition can be adjusted to decrease the white color or coloring oxide can be added into the glaze while maintaining the some body composition.

B. Further Suggestion for More Research

1) Study and create a test in the field of souvenirs production and marketing to enhance Ranong tourism.

2) Creating a test of clay body and glaze in a variety of types for the need of different production. Also including the test to find the glaze and clay body which those establishments can produce by themselves.

Acknowledgment

This research was supported by Suan Suandha Rajabhat University.

References

[1] Provincial Administration. (n.d.). Ranong province. Ranong: Author.
[2] Griffiths, R., Ceram, F.I., and Radford, C. (1964). Calculations in ceramics. England: St. John's Hill.
[3] Pimpawan Wattanopas. (1992). Research report for the ceramic body for ceramic dolls. Bangkok: Department of Science Service, Ministry of Science and Technology.
[4] Khomol Rugsawong. (n.d.). Stoneware body for casting method. Bangkok: Phranakhon Rajabhat Universit.
[5] Grebanier, J. (1975). Chinese stoneware glazes. New York: Watson–Guptill.
[6] Norton, F. H. (1952). Element of ceramics. California: Addison Wesley.

Ruedee Niyomrath was born at Nakhon Sawan province, Thailand, July 4, 1968. She got first class honors in Bachelor of Science, Pranakhon Teacher College, Bangkok, Thailand, 1990, Ceramic Technology. Master of Education, Srinakharinwirot University, Bangkok, Thailand, 1995, Industrial Education. And Ph.D., Technological University of the Philippines, Manila, Philippines, 2003, Technology Management.

From 2009 to the present she works at Faculty of Industrial Technology, Suan Sunandha Rajabhat University, 1 U-Thong Nok Road, Wachira, Dusit, Bangkok, Thailand. Post code 10300. From 1996 to 2008 she worked at Nakhon Si Thammarat Rajabhat University as the lecturer, associate dean, and president assistant. Research interests of her in the field of ceramic science, ceramic art, product design, and technology management. The last published is Efficiency and Potential of Logistic Management in Benjarong Industry (Proceedings of 2012 3rd International Conference on Education and Management Technology (ICEMT 2012), Jeju Island, South Korea, June 29-30, 2012).

Asst. Prof. Dr. Ruedee Niyomrath is the memberships in The Association of Researcher.