

The physical properties of the red clay from the eskişehir region, turkey, and its usage in ceramic bodies

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In this work, the properties of the red clay from Kayakent-Eskişehir region in Turkey were investigated. The specific gravity 2.40 g/cm³, drying shrinkage 11.0%, the firing shrinkage 3.3%, the dry modulus of rupture 45.90 kg/cm², the fired modulus of rupture 91.80 kg/cm², the water absorption 9.0% and the loss of ignition 6.98% were found. As a research, this red clay was tested in the ceramic bodies as 20-30%. As a result of the researches, it was found that the number (1) and (2) body recaptures were suitable as a casting body. Number (2) body gave the more positive results. Upon firing, the body has completely sinterized upon firing and the water of absorption was zero. The physical and casting properties gave particularly the good results and the standart products were obtained.

Key words: Red-Clay, Ceramic Bodies.

Introduction

In this work, the Red-Clay from Eskişehir Region was investigated. The iron oxide content 7.20% and this titan oxide content 1.06% were found.

X-Rays diffraction test showed that this Red-Clay has quartz, albite, illite, montmorillonite and chlorite. DTA Test is shown in Fig. 2 and the illite, montmorillonite, peaks were obtained. The sieve analyses were also carried out. As a industrial experiment, this red-clay was used in the ceramic bodies.

The Results:

Viscosity : 15 second
Liter Weight : 1568 mg.
Thickness : 5 mm.(20 minutes)
Fired Colour : Red
Water of Absorption : 0.0%

Experimental Procedure

The red-clay samples for experiments were obtained from Sivrihisar area. For the characterization of samples, sieve analyses, chemical analyses, X-rays diffraction and DTA tests were carried out. The results of the sieve analyses of the red-clay are shown in Table 1 (TSE 2745).

Quvars : SiO₂
Albit : NaAlSi₃O₈

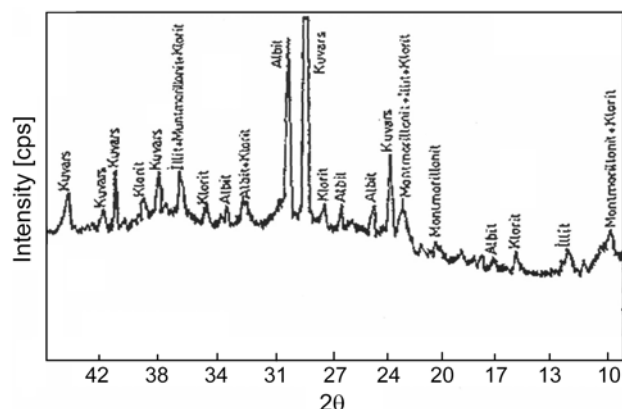


Fig. 1. X-ray Diffraction Test.

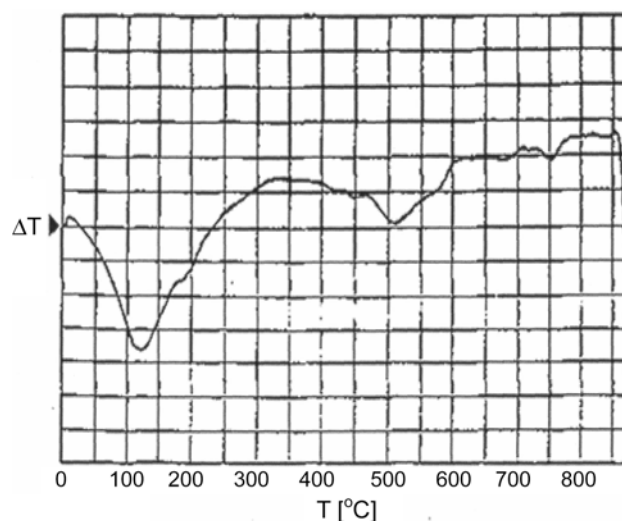


Fig. 2. DTA Test.

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Table 1. Sieve analysis of the red-clay

Sample Size (mm)	%
0.60	12.0
0.60+0.12	1.0
0.12+0.08	2.0
0.08+0.05	2.5
-0.05	82.5
	100.0

Table 2. Chemical analyses of the red clay

Element	%
Loss of Ignition	6.98
SiO ₂	61.34
Al ₂ O ₃	19.54

Illit : K-Na-Mg-Fe-Al-Si-O-H₂O
 Montmori Honit : Ca-Na-Mg-Fe-Al-Si-O-OH. H₂O
 Klorit : Mg-Fe-Al-Si-Al-O-OH

The results of the chemical analyses of the red-clay are shown in Table 2.

The results of the X-ray diffraction are shown in Fig. 1 and those of the DTA test in Fig. 2.

This red-clay has quartz, albite, illite, montmorillonite and chlorite minerals.

The Ceramic Testings results are follows

Test No 1- Checking by Eye:

The Colour: Brown

Hardness : Mohs 3

Test No 2- Resistance to Acid

When we drop 3% HCl, the materials frothed. This shows that the mineral has carbonate.

Test No 3- Moisture Content Determination:

100 mg sample was dried at HOC for 24 hours. Then was weighed again The moisture content was calculated to according to the following formula (TS-2746):

$$\text{moisture content} = \frac{G_v - G_s}{G_v} \times 100 (\%)$$

where

G_s =dry weight (97.40 g)

G_v =wet weight (100.0 g)

$$\text{Moisture content} = \frac{100.0 - 97.40}{100.0} \times 100 = 2.6\%$$

Test No 4- The Specific Gravity Test (TS-4037):

The sample red-clay was ground to the grain size of 149 micron. To calculate the specific gravity, the following formula was used

$$d = \frac{H}{(P_2 + G) - P_i}$$

where

P_2 =distilled water + picnometer (87.42 mg)

G =The sample weight, gm (1.00 g)

P_1 =picnometer + distilled water + sample Weight gm (88.00 g)

$$d = \frac{1.0}{(87.42 + 1.00) - 88.00} = \frac{1.00}{0.42} = 2.40 \text{ g/cm}^3$$

Test No 5- Drying Shrinkage (TS-4037):

The sample were prepared by casting forming. The following formula was used for calculation;

$$\text{Drying Shrinkage, \%} = \frac{\text{Wet Leght} - \text{Dry Length}}{\text{Dry Length}} \times 100$$

$$\text{Drying Shrinkage, \%} = \frac{10.0 - 8.9}{10.0} \times 100 = 1.2 \times 100 = 11.0\%$$

Test No 6- Firing Shrinkage (TSE 4037)

The firing shrinkage was calculated according to the following formula:

$$\text{The firing shrinkage} = \frac{\text{Dry Length} - \text{Fire Length}}{\text{Wet Length}} \times 100$$

$$\text{The Firing Shrinkage} = \frac{8.9 - 8.6}{8.9} \times 100 = 3.3$$

Test No 7 - Dry Modulus of Rupture (TSE-4037)

The samples were prepared by casting forming.

$$\text{The dry modulus of rupture} = \frac{3}{2} \times \frac{P \times L}{b \times h^2} \text{ kg/cm}^2 \text{ where}$$

P =Applied Force, kg

L =Distance Between Support Point, cm

b =Sample Width, cm

h =Sample Thickness, cm

$$\begin{aligned} \text{The Dry Modulus of Rupture} &= \frac{3}{2} \times \frac{3.10}{2 \times (0.7)^2} \\ &= \frac{90}{1.96} = 45.92 \text{ kg/cm}^2 \end{aligned}$$

Test No 8 - Fired Modulus of Rupture (TS-4037)

The moduluss of ruptures of the fired samples were caculated to according to following formule.

$$\begin{aligned} \text{The Fired Modulus of Rupture} &= \frac{3}{2} \times \frac{PL}{b \times h^2} \\ &= \frac{3 \times 6 \times 10}{2 \times 2 \times (0.7)^2} = 91.80 \text{ Kg/cm}^2 \end{aligned}$$

Test No 9-water of Absorption (TS-4037):

The samples fired at 1000 °C were weighed adn put into water. The samples were boiled for one hour and taken out. The samples were weighed again. The water of absorption was calculated to according to the following formula;

$$\text{The Water of Absorption} = \frac{W-D}{D} \times 100$$

The Water of Absorption

$$= \frac{31.510 - 28.900}{28.900} \times 100 = 9.031$$

Industrial Application Works

Red-Clay was tested in the casting slips. The results of the experiments showed that No. (1) and No. (2) Body Receptures gave the best results.

No.1 Body Recepture.

Potassium Feldspar	20%		
Sodium Feldspar	10%		
Vitra Grog	5%		
Red Clay	20%		
Mihallicli-B Kaolin	10%		
Mihallicli-S Kaolin	10%	Sodium Silikat	: 02%
T-153 Casting Clay	10%	Sodium Carbonate	: 01%
Test Results:	100	Water	: 45%

Viscosity	: 30 second
Thiscosity	: 5 mm. (25 minutes)
Fired Colour	: Red
Tixotropy	: None

No 2 Body Recepture :

Potassium Feldspar	: 10%		
Sodium Feldspar	: 10%		
Vitra Grog	: 10%		
Red Clay	: 30%	Sodium Silicat	: 02%
T-153 Casting Clay	: 15%	Sodium Carbonate	: 01%
Hard Mihallicli Kolin	: 15%	Water	: 45%
Bilecik Kaolin	: 15%		
	100		

Conclusions

In this work, the properties of the Red-Clay From Eskişehir Region was investigated. The specific gravity 2.40 g/cm³, the drying shrinkage 11.0%, the firing shrinkage 3.3%, the dry modulus of rupture 45.90 kg/cm², The fired modulus of rupture 91.80 kg/cm², the water absorption 9.0% and the loss of ignition 6.98% were found .

Then the rheological properties of the red clay was investigated. The water of plasticity for Red-Clay high. So to compensate this, the feldspar and vitra brag was used. The casting properties of the Red-Clay body recaptures showed tixotropic property.

As a industrial research, this Red-Clay was tested in the ceramic bodies as 20-30%. The number (1) and number (2) body receptures gave the best results. The Fired colour was red, the body was completely sinterized and water of absorption was zero. The ceramics produced were good in accordance with standards.

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