Analyse Characteristics Physical Properties of Rock Manifestations Geothermal Semurup District of Kerinci Jambi With Hight Temperature

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Abstract. There were some changes of mineral components, internal structure and moisture content of the rocks constituent after the thermal annealing treatment was given at 400, 500, 600 °C. Physical of testing rocks like; density, porosity, specific gravity, Absorption have a relationship with temperature. The test results showed that the average density decreased 0.7 g/cm³, porosity increased 26%, Density unchanged and Absortion increased 35%. The test of rock minerals components X-Ray Fluorescence (XRF).

1. Introduction

Geothermal energy is a renewable energy source that is environmentally friendly (clean and sustainable energy) and is one of the best solutions to overcome the limitation of energy. It makes geothermal energy is so favored by many countries that it has been used as a source of energy, particularly as a geothermal power plant (Rachel, 2015). One of the locations in Jambi that potentially has a geothermal source is hot water Semurup, subdistrict in Kerinci. Therefore it needs a surface manifestations to know the existing of geothermal energy.

Visible manifestations in the area of hot water Semurup Water District, Kerinci, Jambi are the hot springs, rocks and hot mud. Manifestation is an early indication of potential geothermal (Manfred, 2008). To determine the earliest manifestation of the physical characteristics of the subsurface needs first. It was done to at the rocks. The rocks in Semurup area show that the area around the hot spring is composed of andesite. Andesite rocks have special characteristic that is grayish while color and consists of very small grains (Khant, 2013). Thus, this andesite sample should be investigated to know more the physical parameters of andesite so to find the characteristics of the physical properties of rocks though at treatments different annealing temperatures 400, 500, and 600 °C in a furnace (Weiqiang, 2016)

The study of the physical properties of rocks is very important to be done in a geothermal area because it can show the process of the geothermal system. Accordingly, researchers examined the physical properties of rocks that aims, to determine the impact of thermal effects, density, porosity, specific gravity and absorption (Weiqiang, 2016) using the Law of Archimedes as the basis of the research conducted and characterized the content using X-Ray Fluorescence (XRF) (Khant, 2013)

2. Experimental And Methods

The study started from January to March 2017. The testing of the rocks was conducted at the Research Center for a group of materials engineering Lembaga Ilmu Pengetahuan Indonesia (LIPI), it was a test of the physical properties of rocks at different annealing temperature at 400, 500, and 600 °C in a furnace. The density, porosity, specific gravity and absorption rocks were calculated to know at relationship the effect of temperature given. Then, characterized crystal structure of rock X-
Ray Diffraction (XRD) in Laboratorium Physics LIPI. The testing of content using X-Ray Fluorescence (XRF) was done at the Science Building, State University of Hasanuddin (UNHAS). The site of the research object is the source of the hot springs in Semurup, district Kerinci, Jambi.

Temperature Test
To know the test effect of thermal annealing, some steps were done as follows:
1. Rock samples in was cleaned using water, then dried with paper towels.
2. Rocks sample was in to cut rectangular pieces using burrs.
3. To get a clean sample parameters, the researcher used ultrasonic cleaner with a solvent mixture of water 80% + 20% solution of Acetone in the glass beaker.
4. A mixture of water and acetone was used 20 times in ultrasonic cleaning. While at the 5th, 10th, 15th, 20th process, the mixture of water and acetone is replaced. Up to 4 times of cleaning, the water looked clearer.
5. Next is the drying process (using oven sample) at 60 °C for 24 hours
6. Rock sample mass was weighed with Digital Balance GF-600 and put sample plastic bag and labeled.
7. The last step is postheating (annealing) with a temperature variation of 400 °C, 500 °C and 600 °C respectively for 1 hour.

Physical properties of rocks Test
Tests conducted on the physical properties of rocks at the different annealing temperature 400, 500, and 600 °C was done as follows:
1. Rock sample masses was measured in beaker glass with distilled water at variation of temperature (400 °C, 500 °C and 600 °C) three time.
2. To gain the weight + water at without temperature variations (400 °C, 500 °C and 600 °C) the sample was processed in Ultrasonic Cleaner for 12 minutes, then was dried using a tissue. The dry sample then was weighed again with Digital Balance GF-600.
3. The researcher than calculated the physical properties. They are density, porosity, absorption, specific gravity of rocks.

3. Results And Discussion
This study was conducted by collecting the data through experiments that was carried out in same stages. Through the provision of thermal effects at 400, 500 and 600 °C in the rocks to measure the weight and water, we got the results of the physical properties of rocks in the form of density that can be seen below:

| Temperature (°C) | V = M-S  | Density (B = D/V g/cm³) |
|-----------------|---------|-------------------------|
| None            | 0978    | 0.774                   |
| 400             | 0922    | 0.773                   |
| 500             | 3089    | 0.748                   |
| 600             | 1,509   | 0.740                   |

Table 1 Relationship of in density without temperature of 400, 500 and 600 °C can be explained based on Figure 1
Test standard that can be used in determining the density, porosity, specific gravity, and absorption density is ASTM C373-88. In the calculation it should be noted that 1 cm$^3$ of water weighs 1 g. This applies to all three parts of 1000 g of water at room temperature. Then the equation (1) on the outside volume (V) in units of cm, as follows

$$V = M - S$$

Calculating the open pore volume ($V_{op}$) and the watertight part ($V_{ip}$) in units cm, the equation (2), as follows

$$V_{op} = M - D$$

$$V_{ip} = D - S$$

Calculating the density of rocks (B) in units of gr/cm$^3$ of the object test is the result of the air mass or dry divided by the outside volume, including the pores of rocks. Calculating the density of rocks (B) was the equation (4), as follows

$$B = \frac{D}{V}$$

From equation (4) then, the results showed that the density decreased at the 1st test without giving the temperature to 0.774 g/cm$^3$. The second test with the provision of thermal annealing at 400 °C, the density is 0.773 g/cm$^3$. The 3rd test with the provision of thermal annealing of 500 °C, the density is 0.748 g/cm$^3$. The 4th test with the provision of thermal annealing of 600 °C density of 0.740 g / cm$^3$. Based on the value of density in table 1, the greater the temperature given the density will be smaller.

Table 2. Relationship porosity against thermal effects

| Temperature (°C) | V = MS | Porosity (P = [MD] / V) x100% |
|------------------|--------|--------------------------------|
| There is no      | 0978   | 23 619                         |
| 400              | 0922   | 23 752                         |
| 500              | 3089   | 25 509                         |
| 600              | 1,509  | 26 640                         |

Table 2 Relationship of porosity with no variation in temperature, 400°C, 500°C and 600°C can be explained based on Figure 2 below, as follows;
Calculating porosity appears (P) expressed as a percent, so we get the volume of affairs outside. Calculating Porosity looked stated equation (5), as follows;

\[ P = \frac{M - V}{D} \times 100 \]  \hspace{1cm} (5)

From equation 5 then, the results showed that the porosity increases on testing to-1 without giving a temperature porosity of 23.619%, on a test-2 with the provision of thermal annealing of 400 °C porosity of 23.752%, on a test 3 with the provision of thermal annealing 500 °C porosity of 25.509%, in the 4th test by administering thermal annealing at 600 °C porosity of 26.640%. Based porosity values in table 2, the greater the temperature given then the greater porosity.

Table 3. Relationship Absorption rocks against thermal effects

| Temperature (°C) | Absorption (A = [(MD) / D] x100%) |
|------------------|----------------------------------|
| There is no      | 30 515                           |
| 400              | 30 715                           |
| 500              | 34 097                           |
| 600              | 35 989                           |

Absorption of Table 3 Relationship with variations without temperature, 400 °C, 500 °C and 600 °C can be explained based on Figure 3 below, as follows;
Calculate water absorption (Absorption) expressed as a percent, so it has a relationship once absorbed water mass and the mass of the air or dried. Calculating water absorption is expressed equation (6), as follows:

\[
A = \frac{M - D}{D} \times 100
\]  

(6)

From equation 6, the results showed that the porosity increases on testing to 1 without giving a temperature of absorption 30.515% on the test 2 with the provision of thermal annealing of 400 °C absorption amounted to 30.715% on the test 3 with the provision of thermal annealing of 500 °C absorption of 34.097%, in the 4th test by administering thermal annealing at 600 °C 35.989% porosity, by absorption values in table 3.3, the greater the temperature given then absorption will be even greater.

| Temperature (°C) | Specific gravity T = D / (D - S) |
|------------------|----------------------------------|
| There is no      | 1.013                            |
| 400              | 1.014                            |
| 500              | 1.004                            |
| 600              | 1.009                            |

Table 4 Relationship of density with no variation in temperature, 400 °C, 500 °C and 600 °C can be explained based on Figure 4 below, as follows:

Figure 4. Relationships density of rocks against thermal effects

Calculating Density (T) is a test object is resistant to water, compute density (T) to be stated equation (7), as follows:

\[
T = D(D - S)
\]  

(7)

From equation 7 then, the results showed that the density does not change. In the 1st test without giving a specific gravity of 1.013 temperatures, the 2nd test by administering thermal annealing of 400 °C gravity of 1.014, the testing of all three with the provision of thermal annealing of 500 °C gravity of 1.004, in the 4th test with the provision of thermal annealing of 600 °C for 1.009 porosity, density Based on the values in table 4, the temperature does not affect the density because it does not change the mineral components in the rocks.

Conclusion

By knowing the thermal effects on the physical properties of rocks (density, porosity, absorption and density) by providing thermal annealing of 400 °C, 500 °C and 600 °C, then concluded:

1. The greater the temperature given the density will be smaller.
2. The greater the temperature given the porosity and absorption will be even greater.
3. Temperature does not affect the density because it does not change the mineral components in the rocks.

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