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Research Article

DEFORMATION AND ADSORPTION CAPACITY OF KAOLIN THAT IS INFLUENCED BY TEMPERATURE VARIATION ON CALCINATION

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ABSTRACT

Kaolin is a mineral composite derived from clay soil. It has been used for long time in medicine as an antidiarrhea. Antidiarrheal function of kaolin comes from its work locally at intestine as a strong adsorbent. Some contaminants which cause diarrhea in intestine will be adsorbed by kaolin and wasted with faeces. Adsorption capacity of adsorbent agent is influenced by surface properties and its porosity. Improving surface adsorption characteristics of the adsorbent agent will increase its adsorption capacity. Several efforts to increase adsorption capacity of adsorbent have been carried out such as structure modification of matter by chemical or physical ways. Chemical modification uses a complicated method than physical ways. Physical modification can be done by reducing particle matter or with high temperature heating like calcination. Reducing particle needs more time and energy, but with calcination structure modification is formed spontaneously and rapidly with a simple way. Calcination is an endothermic process with high temperature heating, but still under its melting point. With calcinations, the structure will thermally deformed with changes in mineral composite formation. In this research, the effect of calcination temperature variations on kaolin's deformation and adsorption capacity has been studied. Deformation of mineral composite was studied by X–Ray diffractogram from Powder X–Ray Diffractometer, and the adsorption capacity was analyzed by measuring number of Pb being adsorbed by using Atomic Absorption Spectroscopy. The result showed that at the 400^{o}C deformation did not occur yet, but at 600^{o} and 800^{o}C temperature the deformation began. The adsorption capacity of Pb at 400^{o}C raised by 0.377%, but on the contrary, at 600^{o} and 800^{o}C decreased significantly by 7.198% and 20.761%, respectively. Conclusion from those data indicated kaolin has raised adsorption capacity at 400^{o}C, getting more heated the deformation of kaolin occured with lower adsorption capacity.

Keywords: Kaolin, Calcination, Deformation, Adsorption capacity

INTRODUCTION

Kaolin is a natural aluminum silicate hydrate, which is free of most contaminants. Minerals are included in the kaolin is kaolinite, nakrit, decree, and hallosyite ($Al_2(OH)_4SiO_5$). As an antidiarrheal agent, kaolin layers the intestinal wall, exactly as adsorbent that adsorbs toxins and bacteria in the digestive tract, acts to protect the gastrointestinal mucosa exile[1].

Adsorption phenomenon is an accumu-lation of a number of molecules, ions, or atoms that occur at the boundaries of the two phases. The amount of adsorbate accumulates on the adsorbent is affected by particle size and surface area of the adsorbent and the adsorbate. Condensed molecule is called adsorbate, while the substrate surface (solid or liquid) is called adsorbent[2].

Adsorption capacity of the adsorbent can be enhanced with increasing surface area, pore volumes and percent microporosity. One method to increase surface activity for adsorption that is modifying crystal structure or crystal habit of the adsorbent material through heating. Heating material process under its melting point has been commonly used in the field of metallurgy to purify the metal material. This process is called calcination. Calcination usually is used to bring decomposition thermal, phase transition and to remove volatile frac-tions such as CO_2 and H_2O [3].

This work aims at enhancing adsorption capacity of kaolin by calcination and find the deformation of kaolin by variation of calci-nation temperature.

MATERIALS AND METHODS

Pharmaceutical grade powder of kaolin (ex. BDH, England), $PbSO_4.7H_2O$, Nitric Acid concentrated (ex. Merck, USA).

Calcination Process

Kaolin calcinated in graphite crucible at electric furnace (Nabertherm). The graphite crucible has content of Kaolin heated each in different temperature at 400^{o}, 600^{o} and 800^{o}C during 6 hours.

Porosity Evaluation

Porosity is evaluated using porosimeter device *Fisher Sub-Sieve Sizer.* Placed the sample test on test tube then closed with whatman paper filter and porous stopper. Press the stopper till all paper filters got into sample test, run device and watched the mano-meter indicator.

Density Evaluation

The true density of material is tested using pyc-nometer method, where in this test using methanol with 0.788 g/ml as test fluid.

Crystal Characterization

Characterization of kaolin deformation was con-ducted using Powder X-Ray Diffractometer (PXRD) (Rigaku, Geiger Flex).

Adsorption Capacity

Adsorption capacity of the test material was done by measuring the contents of Pb^{2+} that adsorbed by the test material. The levels of Pb^{2+} were determined using the Atomic Absorption Spectroscopy (Shimadzu, AA-6501S).

RESULTS AND DISCUSSION

Reported from previous studies that Kaolin when subjected to the heating process will go through two phases of weight loss. In the low temperature phase (25-650^{o}C), kaolin will be facing loss of water molecules and at the high temperature phase (655-1365^{o}C), kaolin began to decompose [4].

After the calcination process, the tested material has changed the nature differently. The porosity and the true density of kaolin as adsorption surface activity parameters showed changes after different temperature heating. After heating at 400^{o}C, the surface activity was increased by increasing of porosity and true density value, but when the temperature of heating was raised, a decline was noted.

Table 1: Evaluation of Kaolin Porosity

Treatment	Porosity
Kaolin before calcination	0.61
Kaolin after 400ºC calcination	0.75
Kaolin after 600ºC calcination	0.42
Kaolin after 800ºC calcination	0.36

Table 2: Evaluation of Kaolin True density

Calcination Treatment	True Density (g/ml)
Kaolin before calcination	2.6199
Kaolin after 400ºC calcination	2.6275
Kaolin after 600ºC calcination	2.6097
Kaolin after 800ºC calcination	2.6001

Table 3: Contents of Pb2+ and Adsorption Capacity

Calcination Treatment	No.	contents of Pb^{2+} (ppm)	Adsorption Capacity (%)
Kaolin before Calcination	1	0.2936	99.3516
	2	0.2877	99.3647
	3	0.2948	99.3490
Kaolin after 400°C	1	0.1149	99.7463
	2	0.1246	99.7248
	3	0.1239	99.7264
Kaolin after 600°C	1	3.5519	92.1563
	2	3.5493	92.1620
	3	3.5537	92.1523
Kaolin after 800°C	1	9.6802	78.6231
	2	9.6735	78.5723
	3	9.6967	78.5867

Changes during calcination cast for the adsorption capacity of the levels of Pb^{2+}. The results of the determination of Pb^{2+} contents adsorption at the test material seen in mutual accord with the increase and decrease in surface activity parameters (Table 3).

From the data in Table 3, it was found that at calcination temperature 400°C adsorption capacity higher than without calcination, but higher temperature has lowered the adsorption capacity.

Table 4: Comparison of Adsorption Capacity between before and after Calcination

Calcination	%
400°C	Raise 0.3774
600°C	Decrease 7.198233
800°C	Decrease 20.76107

For getting some answer what happen with different nature after calcination treatment. We analyzed the sample by powder X-ray diffractometer then we found picture below.

Figure 1 shows that after 600ºC, crystallinity of kaolin was broken. Raise more heat further damaged the deformation of kaolin structure to becoming more amorphous. There has connectivity of kaolin structure and adsorption capability. At 400ºC, the kaolin crystallinity looked more increase cause of removing some volatile compound in its pores then making percentage of microporosity increase.

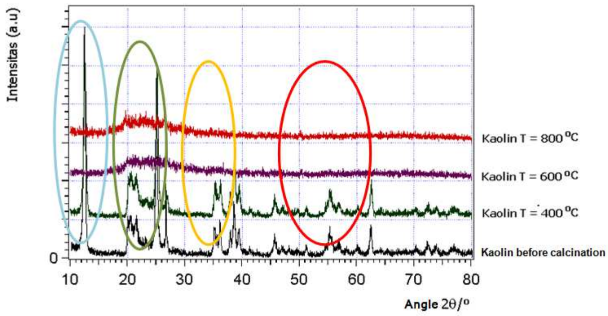

Fig. 1: Powder X-Ray Diffractogram (PXRD) of kaolin before and after calcination

CONCLUSION

Calcination at 400ºC made crystallinity kaolin higher that is due to elimination of some volatile compound and raise its percent microporosity then the adsorption capability increased. Calcination temperature higher than 600ºC destroyed the kaolin structure making loss of its adsorbability nature. There has relationship between adsorption capability with crystalline form of kaolin. The crystalline form has better adhesivity force, conversely in amorphous form has reduced adhesivity force.

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