Characteristics of KyungJu-II Bentonite Heated With Different Potassium Concentrations

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1. Introduction

Buffer is the major component of engineering barrier with canister in high-radioactive waste disposal. Bentonite is considered as a buffer material, because it has properties such as high swelling potential, low hydraulic conductivity and high thermal conductivity. But bentonite lost its major functions by long-term exposure to the decay heat from high-radioactive wastes and geochemical conditions of groundwater [1]. This study carried out heating experiments of KJ-II bentonite at high temperature condition with different potassium concentrations.

2. Methods

2.1 Samples

Table 1. The list of bentonite Samples

	Sample No.	Mixed solution
Type-1	Ca-1	D.I. water
	Ca-2	0.005M KCl-solution
	Ca-3	0.05M KCl-solution
	Ca-4	0.1M KCl-solution
Type-2	Na-1	D.I. water
	Na-2	0.005M KCl-solution
	Na-3	0.05M KCl-solution
	Na-4	0.1M KCl-solution

The material used in this study was KyungJu (KJ)-II bentonite. Two sets of samples were prepared by two different pretreatments (table 1). For type-1, KJ-II bentonite was washed with D.I. water. The fine particles of the bentonite were collected after centrifugation. For type-2, the bentonite was saturated with 1M NaCl, then the samples were washed with D.I. water to remove Cl^{-}. The fine particles of KJ-II bentonite were collected after centrifugation. The collected samples were completely dried using the freeze-dry method.

2.2 Experiment procedure

The samples(type-1 and type-2) were mixed D.I. water and KCl-solutions of 0.005M, 0.05M and 0.1M at a ratio of 1(0.5 g) : 2(10 mL), respectively. The mixed samples were agitated to get homogenized at 120rpm for 20mins and heated in furnace at 150℃ for 24hours (Fig. 1).

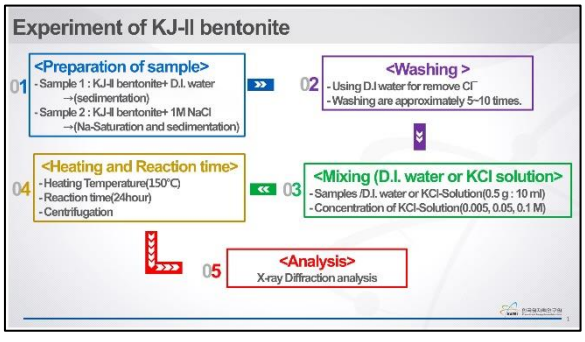

Fig. 1. The bentonite Experiment procedure.

3. Results and Discussion

The results of XRD indicated major constituent minerals of KJ-II bentonite were smectite, albite, orthoclase, quartz, cristobalite and calcite (Fig. 2). The slight difference in the intensity was identified at Ca-1 and Ca-2 as well as Na-1 and Na-2, which were heated with D.I.water and 0.005M KCl-solution, respectively. But, the results of XRD from Ca-3 and Na-3 samples (reacted with 0.05M KCl-solution) as well as Ca-4 and Na-4 samples (reacted with 0.1M KCl-solutions) showed the inflected 2-theta of smectite which was confirmed approximately 7.16.

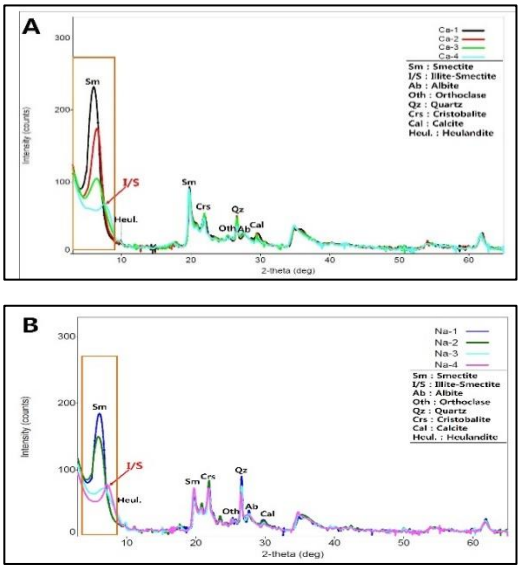

Fig. 2. X-ray diffraction patterns from the samples heated with D.I. water and various KCl-solutions([K+]= 0.005M, 0.05M, 0.1M). A: Type-1, B: Type-2.

In general, d(0,0,1) value of smectite was 15 Å. The values of d(0,0,1) of Ca-1and Ca-2 were similar with that of Na-1 and Na-2, which were approximately 14.71~14.55 Å. But, Ca-4 and Na-4 samples showed a decreased in d(0,0,1) values, which were approximately 12.34 Å. The results showed that dehydration occurred between the interlayers and the ion exchange of potassium and cation, by reaction with high-concentration KCl-solutions at 150℃.

4. Conclusion

The slight difference in the intensity was identified between Ca-1 and Ca-2(heated with D.I. water) as well as Na-1 and Na-2(heated with 0.005M KCl-solution). But, Ca-3 and Na-3 samples (heated with 0.05M KCl-solution), and Ca-4 and Na-4 samples (heated with 0.1M KCl-solutions) showed the variation in 2-theta and d values compared to that of smectite. It indicated that dehydration occurred between the interlayers and the ion exchange of potassium and cation, by heating with high KCl concentration solutions at 150℃. The result indicated that smectite transforms into illite at high temperature with high concentration potassium.

ACKNOWLEDGMENTS

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REFERENCES

[1] J.W. Lee, and W.J. Cho, “Hydrothermal behaviors and long-term stability of bentonitic buffer material”, J.of the Korean Radioactive Waste society, v. 5(2), p.145-154(2007).

[2] L.C. Carniel, R.V.Conceicao, N. Dani, V.F. Stefani, N.M. Balzaretti, R.D. Reis, “Stuctural changes of potassium-saturated smectite at high pressures and high temperatures: Application for subduction zones”, Applied clay Sience, v.102, p.164-171 (2014).