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Phase Transformation of Coal Ash under Biochemical Condition and Its Significance

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Introduction

Coal ash is predominantly composed of high temperature solid. Many progresses in researches on improvement of soil with coal ash have been made in recent years. The discovery of clay formation during weathering of alkaline coal ash (C. Zevenbergen, et al., 1999) makes us believe that phase transformation of coal ash can occur under certain conditions. In this paper, experiments aiming at transforming coal ash into clay under biochemical condition were briefly described and discussed.

Materials and Methods

(1) Coal Ash (CA): the coal ash is obtained from Luquan city in Heibei province. The CA was dried under 40°C for 24 hours and then ground to sift through 0.045 mm sieve. (2) Deionized Water (DW). (3) Nutrient Liquid (NL): mix the methanol, ammonium chloride and $\text{NH}_4\text{H}_2\text{PO}_4$ in the proportion of 100:5:1 of the C, N, P and dilute the mixture by DW. (4) Filtrate: Sewage Sludge is taken from Qiaoxi sewage plant in ShiJiazhuang city and is soaked in the proportion of 1:25 (solid: liquid wt/wt) with the DW, intermittently whisked. After 7 days the sewage sludge liquid is filtrated by the quantitative middling-rate filter paper.

The coal ash was divided into six 20g shares and was deposited in six 500ml glass conical flasks respectively. These vessels were divided into 2 groups. Group1 were numbered by F1-4, F1-5, F1-6 and group2 F1-7, F1-8, and F1-9. Group1 and group2 were mixed with filtrate and DW respectively with proportion of 1:5 (solid: liquid wt/wt).

Both the two groups were cycle-stirred intermittently and the pH values were measured every 3 or 4 days. Each vessel was added into 50ml NL every 15 days. After 180 days, F1-4 and F1-9 were extracted for SEM-EDS and XRD analysis. F1-4-1 and F1-9-1 were dried powder extracted apart from the suspensions of F1-4 and F1-9 vessel quickly after they stopped stirring, F1-4-2 and F1-9-2 were dried powder extracted apart from the suspensions of F1-4 and F1-9 vessel 20 minutes after they stopped stirring.

Results and Discussion

pH curves of the two groups (Figure1): The pH curve of group 2 ascend at the beginning and then fall down, while group 1 decline smoothly all the time. This difference might be caused by the different adding liquids. Filtrate was added into the group 1, and there are plenty of microbes in the filtration and the microbes often produce the acid, so the pH value in group 1 declined all the time. While DW was added into the group 2, the DW joins the coal ash sufficiently and the alkalescency elements are set free from the coal ash, which

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lead to the ascend of pH value at the beginning, and the subsequent decrease of the PH value was caused by the adding acidic NL (pH□4.5).

The SEM-EDX result (Figure2): some silky, bunchy and bandy materials were found around or joint the granules of the coal ash from the SEM image. The EDS analysis indicated the high content of Si and Al besides Cl. High content of Cl might be attributed to the Nutrient Liquid. Cl prefers to combine with cations dissolved from coal ash and form new halid.

X-Ray analysis (Figure3): besides the predominant peaks of molite, ammonium chloride, and quartz, the peak indicated of clay minerals was also found, though it was very weak. Also there are some other unidentified peaks. The other problem is that the SEM-EDS and XRD analysis were not in situ identical position, further investigations, such as TEM analysis must be taken.

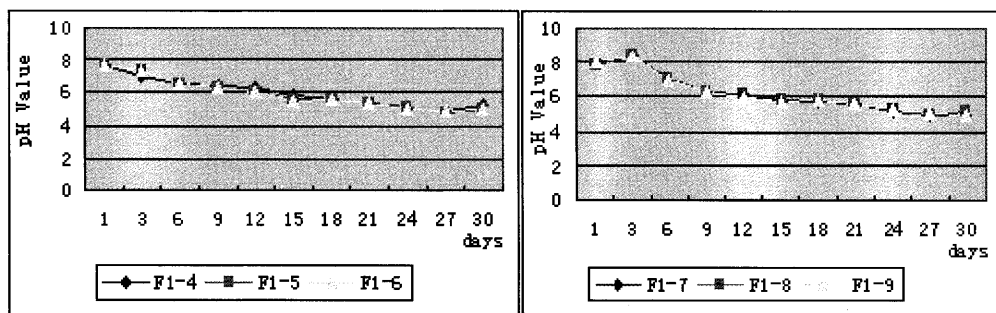


Figure1 variation of pH value of group 1 and group 2

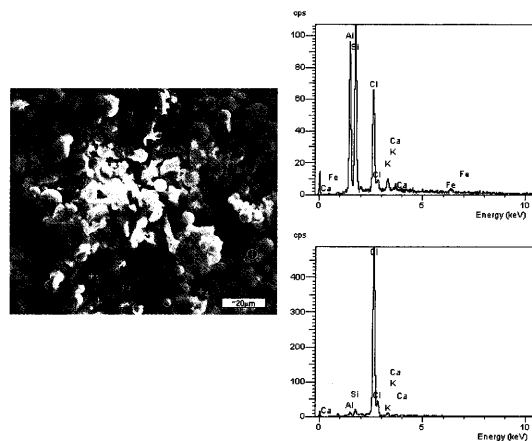


Figure2 SEM image and EDS spectrum of F1-4-2

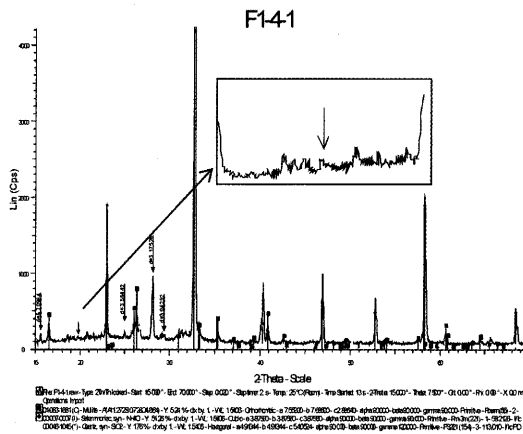


Figure3 XRD result of F1-4-1

Conclusions

Our research suggests that coal ash might be transformed into clay minerals under biochemical condition in a relatively short period. Despite the preliminary investigation, this experiment has show great potential and significance in the transformation of coal ash for soil improvement.