

# Phosphorus Recovery from Charcoal of Sewage Sludge using NaOH

Masaaki Takahashi<sup>1</sup>, Yukimasa Takemoto<sup>1</sup>, Ken Onishi<sup>2</sup>

<sup>1</sup>Yokkaichi University, Kayou-tyo 1200, Yokkaichi, Mie, Japan

<sup>2</sup>Mie Chuo Kaihatsu Co., Ltd, Hachiya4713, Yono, Iga, Mie, Japan

## Abstract

In order to recover phosphorus, charcoal of sewage sludge was mixed with a NaOH aq. solution and heated at 120°C in an iron vessel. After this treatment, water was added, and treated charcoal was separated by filtration. The phosphorus was recovered by crystallization from filtrate followed by cooling at a low temperature. The recovered phosphorus was considered sodium phosphate ( $\text{Na}_3\text{PO}_4 \cdot 12\text{H}_2\text{O}$ ) from recovered condition and X-ray analysis. The phosphorus recovery rate was estimated at about 60%-70%. Reuse of the alkali which has not reacted with phosphorus, and concentrating method of extracted phosphorus using multistage filtration was investigated.

**Keywords:** *Sewage Sludge, Chemical treatment, Material recovery, NaOH*

## 1. Introduction

High volumes of sewage sludge are discharged in Japan and their amounts are increasing every year. In order to solve the problem, one method, carbonization technique, has been introduced (Hiroshisa Hinata et.al.1996), which produces charcoal of sewage sludge. This charcoal is regarded as useful for many usages as a fuel, reducing agent, cement raw material and absorbent. However, carbonized sewage sludge, contains significant amounts of phosphorus, and phosphorus in the charcoal makes a bad influence for these usages. Phosphorus removal techniques from them have not been developed, utilization of the charcoal of sewage sludge are very limited, and mainly used as an authentic fuel.

In order to expand the wider utilization of charcoal, phosphorus recovery technique are regarded as useful, and some studies of chemical extraction methods using sulfuric acid (M. Takahashi et.al. 2001) or sodium hydroxide (Y. Takahashi, et .al. 2001) are carried out.

Phosphorus is thought to exist mainly as a form of aluminum phosphate in the sludge. We found that phosphorus in the charcoal or ash can be effectively extracted under hydrothermal condition (Kunihiko Sato et.al 2004; Masaaki Takahashi et. al. 2010) compared with a conventional alkali extraction method. In this method, charcoal is mixed with NaOH aq. solution, and heated to 70°C-160°C, after treatment, phosphorus can be extracted using hot water. Phosphorus can be recovered by crystallization from extract at low temperature as shown in **Figure 1**. In a previous study (Masaaki Takahashi et. al., 2013) we investigated the best phosphorus recovery conditions as follows.

Charcoal / NaOH; 50g:30g

Charcoal / NaOH aq. Solution ; 50g: 70ml

Heating temp ; 120°C

Heating time ; 2 hour

However, this method has some problem to be solved.

- ① About 30% of the NaOH which is added to the charcoal, can not be used in the reaction, and remains in the residue water.
- ② In order to crystallize phosphorus as sodium phosphate, a concentrating method of phosphorus containing water with less energy consumption is needed.

In order to solve these problems, we investigated the reuse of the non-reacted NaOH, and concentrating method of phosphorus containing extract.