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Granulated coal ash – used method for remediation of organic matter enriched coastal sediments

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Abstract

Fukuyama inner harbor is an enclosed bay located in the western Seto Inland Sea of Japan. This area has many serious problems, such as outbreak of malodorous gas, raw scum, eutrophication and blue tide. The purpose of this study is to propose a valuable method for remediation of organic matter enriched coastal sediments using granulated coal ash (GCA) for the restoration of water environment in the bay. Field experiments were carried out to evaluate the suppression of nutrients, malodorous gas, and raw scum by GCA, as well as to understand the restoration of biological environment. Covering layer of GCA on the sea bottom sediment of the harbor was constructed by a crane ship. Three experimental sites (each 1800m^2) were constructed with different GCA layers (70cm, 50cm, and 30cm) and a control site was established. The improvement effects of covering layer made by GCA were evaluated by field observations. The number of outbreak of raw scum on the water surface decreased after covering GCA on the bottom sediment. It was also confirmed that the concentration of malodorous components gas of the experimental sites was lower than that of the control site. These suggest that GCA has a capability to reduce the malodorous components and raw scum. From our findings, it can be concluded that GCA covering work is valuable for improving water and sediment environments in the bay. And it provides an effect method to mitigate the organic matter enriched coastal sediment problems.

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Keywords: Granulated coal ash; Remediation; Coastal sediment; Hydrogen sulfide; Malodorous component

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1. Introduction

Fukuyama inner harbor is an enclosed bay located in the western Seto Inland Sea of Japan. Excessive amounts of organic matter enriched sediments have accumulated around the innermost area of the bay due to the outfall of domestic wastewater. Phosphates are released by the decomposition of organic matter existing in the sediment (Lee et al., 2000). This area has many serious problems, such as outbreak of malodorous gas, raw scum, eutrophication and blue tide. It has been confirmed that these problems are partly caused by the decomposition of organic matter in the sediment. Many methods, for example dredging, have been proposed for the restoration of water environment. However, they entail a lot of costs. Recently, the method using granulated coal ash (GCA) is widely used for sediment remediation (Fujiwara et al., 2009). It has been proved that GCA can absorb the compounds of phosphorus, nitrogen and sulfur (Asaoka et al., 2009). Moreover, the decomposition of sediment can be enhanced by GCA (Hibino et al., 2006). The purpose of this study is to propose a valuable method for the restoration of water environment in Fukuyama inner harbor using GCA.

2. Materials

2.1. Granulated Coal Ash

GCA was manufactured by mixing coal ash powder with a small amount of cement and adequate amount of water. The size distribution of GCA was similar to that of gravel. Picture 1 presents physical appearance of GCA and coal ash. Since the main material of GCA is the coal ash achieved from the coal-fired power generation, therefore it is expected that the environmental loads resulting from industrial wastes will be reduced if GCA was used. Moreover, it is considered that it may be possible to transform GCA into an effective resource for treating organic matter enriched sediment. If it is possible to effectively remediate the organic matter that negatively affects the environment, the enormous costs for the disposal of sediment will be reduced considerably.

2.2. Physical Properties of Granulated Coal Ash

GCA consists of particles that ranged from coarse sand to gravel. The mean diameter of GCA is approximately 20mm. Moreover, the particles is a porous material which has a small specific gravity. The particle density of GCA ranged from 0.8 to 1.1 t/m^3 in dry condition, and 1.0 to 1.4 t/m^3 in wet condition. It has been reported that GCA was able to adsorb phosphate and hydrogen sulfide (Asaoka et al., 2010). And, it has already been reported that there is no elution of heavy metal from the hardened material made of coal ash (JSCE, 2009).

Picture 1. (a) Physical appearance of GCA; (b) Physical appearance of coal ash.

Table 1. Chemical component of granulated coal ash.

Chemical Component		Percentage (%)
Silicon dioxide	SiO_2	44
Aluminum oxide	Al_2O_3	13
Calcium oxide	CaO	21
Carbon	C	9
Others	-	13