Phosphate Release and Uptake in A/O process by Activated Sludge Cultivated with Cow's Milk

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(Received October 5, 1998)

Abstract

Generally, activated sludge releases phosphate under anaerobic condition and takes up one under oxic condition. Phosphate release by activated sludge cultivated with cow's milk was not detected under anaerobic condition. Subsequently, excess phosphate uptake by the sludge was observed under oxic condition. The sludge seemed to be starved of phosphorus because amount of phosphorus in cow's milk was less in comparison with usual wastewater. The other activated sludge cultivated with cow's milk added phosphorus released phosphate under anaerobic condition. Consequently, it was confirmed that phosphate release and uptake by activated sludge considerably depended on amounts of phosphorus in feed used during cultivation.

Introduction

There are a number of reports on phosphate release and uptake in anaerobic/oxic (A/O) process by activated sludge. Fukase et al.[1] reported that activated sludge during a cycle of fill and draw released phosphate under anaerobic condition and took up phosphate more than released one under oxic condition. The enhanced biological phosphorus (bio-P) removal attracted many workers who were studying on biological phosphorus removal from wastewater.

Comeau et al.[2] proposed biochemical model for enhanced biological phosphorus removal. On the assumption that a group of bio-P bacteria exists in activated sludge cultivated with A/O process, they considered that the bacteria reserved polyphosphate under oxic condition as an energy source for the transport and storage of carbon substrate under anaerobic condition. Since the bio-P bacteria utilizes the energy of polyphosphate to transport outer carbon substrate into cell under anaerobic condition, the polyphosphate is resolved and the phosphate cut off is released consequently from cell, and the bio-P bacteria takes up phosphate under oxic condition and synthesizes polyphosphate to reserve energy in cell.

Previously, we attempted a cultivation of activated sludge with cow's milk as a sample for the education of environmental science.[3] This time, we studied on phospho-

rus metabolism of the activated sludge cultivated with cow's milk. The sludge did not release any phosphate under non-aerated condition, and took up excess phosphate under successive oxic condition.

The purpose of this paper is to describe studies on the phenomena induced by the activated sludge cultivated with cow's milk, which differed from popular phosphorus metabolism mentioned above.

Materials and Method

Original activated sludge used to experiment was taken out from aeration tank of a sewage treatment plant. The following groups of the sludge were cultivated about one month under A/O condition of 3hr/3hr, with fill and draw method by feeding once a day.

Group 1 : activated sludge cultivated with cow's milk of 5mL/L (C1),

Group 2 : activated sludge cultivated with cow's milk added phosphate (0.02g/L) of 5mL/L (C2),

Group 3 : activated sludge cultivated with artificial sewage of 10mL/L (A1), and

Group 4 : activated sludge cultivated with artificial sewage not contained phosphate of 10mL/L (A2).

Artificial sewage consisted of glucose of 33.3g, polypeptone of 33.3g and potassium dihydrogenphosphate of 3.33g per tap water of 1L.[4] Artificial sewage not contained phosphate consisted of glucose of 33.3g and polypeptone of 33.3g per tap water of 1L.

Procedure to observe phosphate release and uptake in anaerobic/oxic (A/O) process of each activated sludge was as follows; MLSS in reactor (2L) was adjusted to 2500-3500mg/L. Anaerobic state in the reactor was obtained with bubbling of nitrogen gas, and after addition of feed to the cultivation, the mixed liquor of 10mL was sampled at regular intervals. After 2hr, aeration into the mixed liquor was started and the mixed liquor of 10mL was sampled at regular intervals. The liquor was centrifuged (2500rpm, 1min), and phosphate and TOC in the supernatant were analyzed with ion chromatograph (Dionex 2000i/SP) and TOC analyzer (Shimadzu TOC-500) respectively. The precipitates were decomposed in an autoclave and the amount of phosphorus was analyzed based on molybdenum blue reaction (JIS K 0102).

Results and Discussion

Fig. 1 shows a pattern of phosphate release and uptake by the activated sludge cultivated with cow's milk (C1 sludge). The phosphate release was not detected under no aeration and excess phosphate uptake was observed under subsequent oxic condition. The initial total amount of phosphorus reserved to the sludge was ca. 8mg/gMLSS. On the other hand, A1 sludge released phosphate under no aeration and took up one under subsequent aeration (Fig. 2). The initial total amount of phosphorus reserved to the sludge was ca. 15mg/gMLSS. C: N: P in cow's milk used to cultivation was ca. 1: 0.1: 0.01 as compared with ca. 1: 0.1: 0.02 in artificial sewage. The phenomena

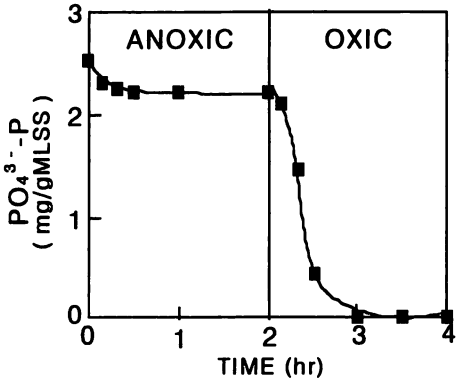

Fig. 1 Time course of phosphorous in reactor (C1 sludge)

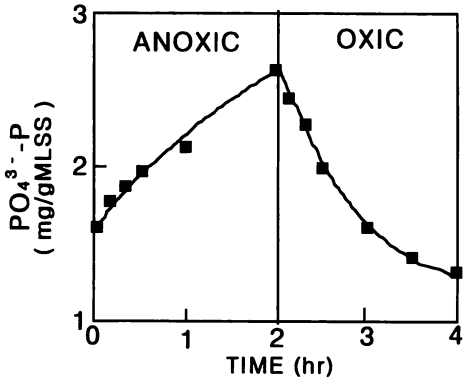

Fig. 2 Time course of phosphorous in reactor (A1 sludge)

on phosphate release seemed to concern the amount of phosphate reserved in cell.

Then, it was investigated whether A2 sludge released phosphate or not under no aeration. As the result, a pattern of phosphate release and uptake in the A2 sludge was similar to that of C1 sludge, and the initial total amount of phosphorus reserved to the sludge was ca. 8mg/gMLSS. This suggested that it was difficult to accumulate polyphosphate in cell in case of cultivation with feed of low concentration of phosphorus. However, the constitution of bacteria in the sludge seemed not to be different because the sludge took up phosphate excessively under subsequent oxic condition.

After C1 sludge and/or A2 sludge took up phosphate once and consumed carbon in the cell under oxic condition during one day, the trial to phosphate release under no aeration was perfomed. The results indicated that the more polyphosphate was reserved in cell the more phosphate was released to the mixed liquor under no aeration. On the other hand, the more polyphosphate was reserved in cell the longer time lag of phosphate uptake was needed under subsequent oxic condition and rate of phosphate uptake was slow (Fig. 3A). It suggested that the need of phosphate uptake was decreased in case of the sludge reserved phosphate to some degree. It also suggested that activated sludge usually utilized energy combined to polyphosphate under anaerobic condition was able to repeat phosphate release and uptake in A/O process and lag phase was necessary to use energy of polyphosphate reserved in cell under anaerobic condition, in the case of the sludge unable to utilize the energy under anaerobic condition. In this case. the amount of carbon reserve in cell seemed to be almost the same, because the patterns of TOC decrease in the mixed liquor were similar in spite of difference of amounts of reserve of phosphorus (Fig. 3B). Further, the pattern of phosphate release and uptake in the C2 sludge was similar to that of A1 sludge.

These results suggested that phosphate release and uptake by activated sludge considerably depended on amounts of phosphorus in feed used to cultivation and the activated sludge of phosphorus starvation was not able to release phosphate under

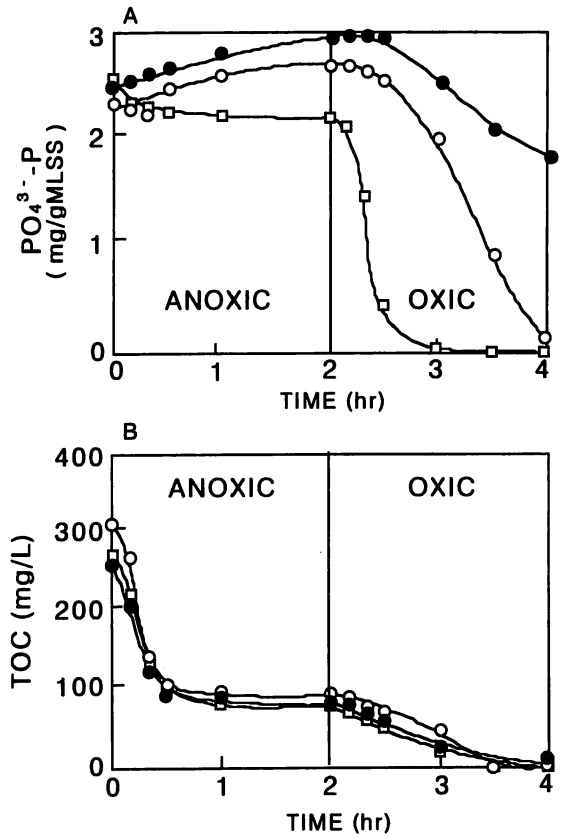

Fig. 3 Relation between initial phosphorous amount accumulated in cells and release or uptake of phosphorus in mixed liquor (A), and TOC decrease during anoxic and oxic conditions (B). Initial phosphorous amount accumulaed in cells is 8mgP/gMLSS (-□-), 15mgP/gMLSS (-○-) and 20mgP/gMLLS (-●-).

anaerobic condition.

Reference

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