

## The effect of microwave irradiation on the acidogenesis of waste activated sludge

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### Abstract

The effect of microwave irradiation on waste activated sludge was investigated in order to improve solubilization. a different levels of microwave irradiation time were varied within a range from 1 min to 15 min. When WAS was pretreated at 1, 3, 5, 7, and 15 min, the SCOD concentration increased according to microwave irradiation time. A simple batch procedure was used to measure the VFA potential, i.e. the amount of VFA that can be formed through digestion of organic constituent in sludge. At equilibrium point, TVFA in the case of 1, 3, 5, 7 and 15 min microwaved sludges was 8%, 122%, 243%, 279% and 232% higher than that in the case of raw sludge, respectively.

### INTRODUCTION

The effective treatment and disposal of sludge have been one of major concerns in domestic wastewater treatment processes. Anaerobic digestion has long been used as an economical option to treat sludge generated [1, 2]. The anaerobic digestion conversion process of a waste activated sludge (WAS) biomass to methane gas contains several biological reaction steps. It is thought that when WAS is transferred from aerobic to anaerobic surroundings, part of the biopolymer is hydrolytically converted to lower-molecular-weight components and released immediately outside cells with other comparatively low-molecular-weight intracellular substances [3].

Various mechanical, chemical, and thermal methods to solubilize or hydrolyze sludge cells have been suggested as pretreatment options to improve anaerobic digestion. The main applications of microwave irradiation today include food processing, wood drying, plastic and rubber treating as well as curing and preheating of ceramics[4]. We tried to apply microwave in the field of pretreatment Therefore, this study was conducted (1) to examine solubilization of waste activated sludge (2) to investigate VFA potential according to different microwave irradiation time.

## **MATERIALS AND METHODS**

### Sludge preparation and microwave irradiation

Waste activated sludge (WAS) was collected from the Pohang municipal treatment plant, Korea. The sludge stored at 4°C fridge, of which concentration was adjusted to 2.6 % total solid (TS) by gravity settling. A microwave oven (Samsung, RE-S50, 2450MHz, 1100W) was used for experimentation. The oven was equipped with magnetron. Sample (500g) was poured into a glass vessel (height = 1.5cm, width = 13.3cm, length = 25cm ). Sample was put directly direction to magnetron Centrifuge (specification), which operated for 15 min at 15,000 rpm and 4°C, was used to obtain soluble sample.

### Biochemical acidogenic potential test

The sludge is digested under anaerobic conditions until the VFA concentration reaches a stable maximum level, called the biochemical acidogenic potential (BAP).

Sludge was digested under anaerobic conditions (Temp.=35°C, rpm=140) using shaking incubator (JEIO-TECH SI-900R). Digestion was carried out in 500-ml Wheaton bottles sealed with rubber stoppers. The bottles were purged with nitrogen gas to remove oxygen. The VFA formed in the bottles through digestion of organic matter by acidogenic microorganisms was then followed by regularly taking samples through the stopper with a syringe for VFA analysis. VFAs concentrations were measured until a maximum level, representing the VFA potential, was reached. The samples were filtered through 0.45 µm membrane filters. The pH was measured before and after digestion of the samples.

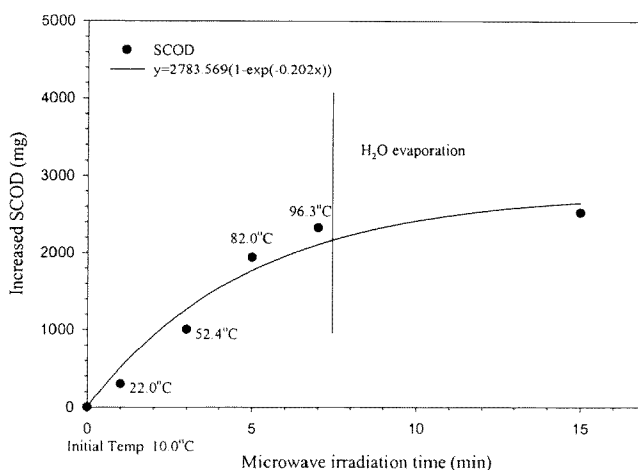
## **RESULTS and DISCUSSIONS**

### Effect of microwave irradiation on solubilization of WAS

It is expected that suspended solids or some colloidal nonsoluble materials in sludge can be solubilized when sludge is irradiated with microwaves, leading to leaching of soluble COD (SCOD) from sludge into bulk solution. Figure 1 depicts the changes in release of organic compounds after microwave irradiation. (SCOD concentration was expressed by mass unit) When WAS was pretreated at 1, 3, 5, 7, and 15 min, the SCOD concentration increased according to microwave irradiation time. The significant increase of SCOD was attributed to the breakup of microbial cells leading to the release of intracellular material. [5]

This indicated the microbial sludge cells, major constituents of sludge, were disintegrated by

microwave treatment primarily due to the dipole rotation movement on flocs and individual cells and their components were released to the outside of the cells. Furthermore, soluble protein and carbohydrate concentration increased as a function of microwave irradiation time (data is not shown). Proteins are the principal constituents of the animal organism and they contain carbon, which is common to all organic substances, as well as hydrogen and oxygen. In addition they contain, as their distinguishing characteristic, a fairly high and constant proportion of nitrogen [3]. Evaporation phenomena exists after microwave irradiation 7min point. Evaporated material is most of water. In the microwave irradiation 15min, it was come up to 25% mass reduction.



**Figure 1.** Changes of increased SCOD as a function of microwave irradiation time.

#### Acids production from disintegrated wasted activated sludge

The productions of the various volatile fatty acids including acetic acid, propionic acid, n-butyric acid, iso-butyric, n-valeric acid, iso-valeric acid, and caproic acid for WAS samples undergoing different microwave irradiation time examined using the BAP test. Figure 2 shows the variation in VFA production (expressed as acetic acid for comparison purpose) according to microwave-irradiation time. At equilibrium point, TVFA in the case of 1, 3, 5, 7 and 15 min microwaved sludges was 8%, 122%, 243%, 279% and 232% higher than that in the case of raw sludge, respectively. Despite VFA formation, the pH did not decrease during digestion. The pH maintained at 6.8-6.9 (SD: 0.1) in all digesters regardless of microwave-irradiation time. In addition, the effect of pH is negligible within a pH range from 4.3 and 7.0 according to Elefsiniotis

and Oldham (1991). [6]

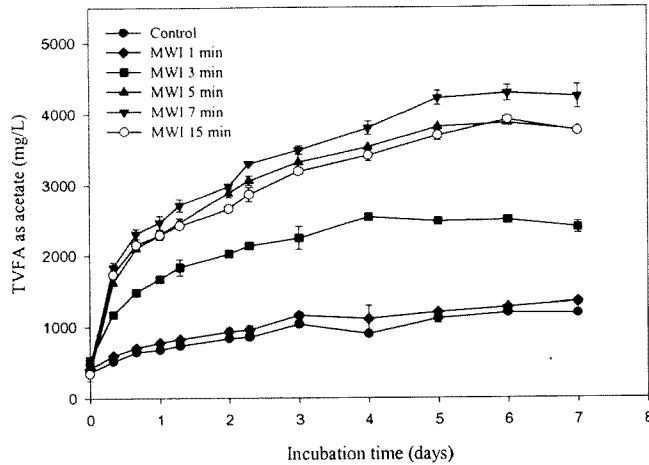


Figure 2. Transformation of total VFA's concentration under different microwave irradiation time.

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