

## Resourcing and Ultimate Disposal of Pretreated Excess Activated Sludge

Yoshiki Sano\* and Osamu Ariga\*

**ABSTRACT:** In our country, activated sludge process is the most popular for the treatment of organic industrial waste water and municipal sewage. Moreover, quick promotion of municipal sewage system plan in this country will soon result in serious problems of the ultimate disposal of excess sludge.

In this work, pretreatment and resourcing of excess sludge from municipal sewage plant are discussed as well as possible minimization and stabilization of the excess sludge. In general, alkali especially hot alkali was more effective than acid for degradation of sludge. But, SVI which relates to the kind of microorganisms influenced on the degradation index, i.e. floc formation cells were more easy to degrade than filamentous bacteria.

Moreover, the authors suggested a few of the ultimate disposal of the excess sludge although there is none of effective method for complete disposal.

### I. Introduction

Activated sludge process is the most popular as treatment of both organic industrial waste water and municipal sewage in our country. However, it is impossible to avoid the production of excess sludge in this process, because the activated sludge process principle of this process bases on a transformation of contaminative components to microorganisms. Nowadays, the majority of the excess sludge from the municipal sewage plant and industrial waste water plant is ultimately disposed in land reclamation after dewatering and burning procedures. However, a rapid promotion of the municipal sewage system plan in this country, will bring on a serious problems of increasing of excess sludge to be treated.

The energy amounts and costs which necessary to burn sludge are huge even now. Moreover, the burning procedure destroys the circulation chain of the materials in ecological systems.

From this view point it may be the most desirable that, if we can utilize the excess sludge treatment, i.e. those are pretreatment of sludge

and the ultimate disposal of pretreated materials. First problem is degradation of solid components of the sludge. Secondly, problems of ultimate disposal of pretreated excess sludge are very complex and difficult to solve. Nowadays, there are no perfect methods for the ultimate disposal. In this paper, outlines of pretreatment of excess sludge by mineral acids and alkali are described. Furthermore, something about the utilization are discussed. Moreover, a suggestion will be made on ultimate disposal.

### II. Pretreatment of Excess Sludge

#### (1) *Treatment by acid or/and alkali*

Results of treatment by mineral acid and alkali are shown in Fig.1. The degradation index is defined by Eq.(1).

$$\text{Degradation index} = (W_0 - W) / W_0 \times 100 \quad (1)$$

where  $W_0$  : sludge conc. before treatment,  
 $W$ : sludge conc. after treatment.

At room temperature, grades of degradation by the acid and alkali are not so remarkable but 20—50%. It is clear that effect of alkali for sludge degradation was larger than acid in all concentration ranges.

As shown in Fig.1, degradation of solid materials proceeds with time, and the same time,

\* Faculty of Textile Science & Technology, Shinshu Univ.  
Ueda, Nagano, 386 Japan.

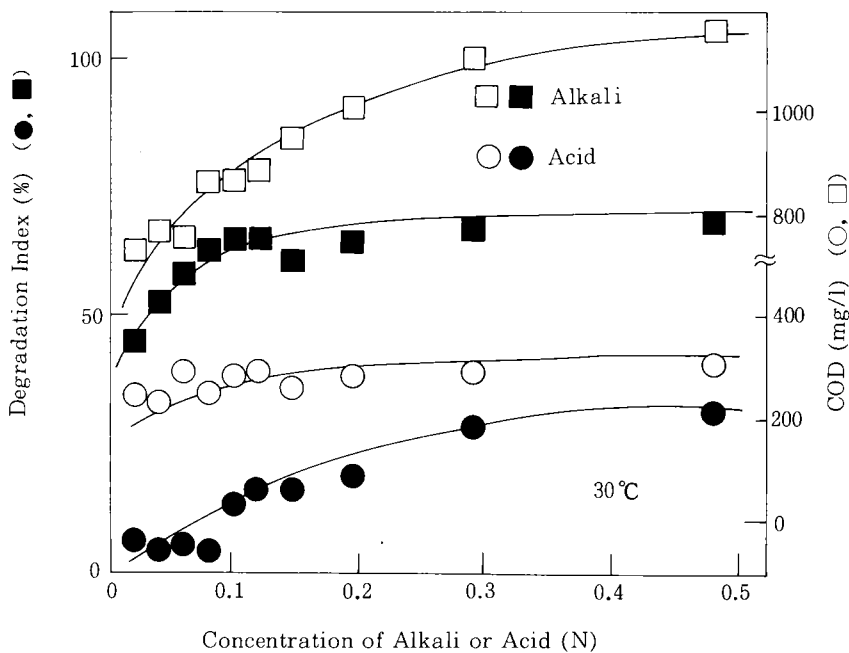


Fig.1 Sludge treatment by alkali or acid

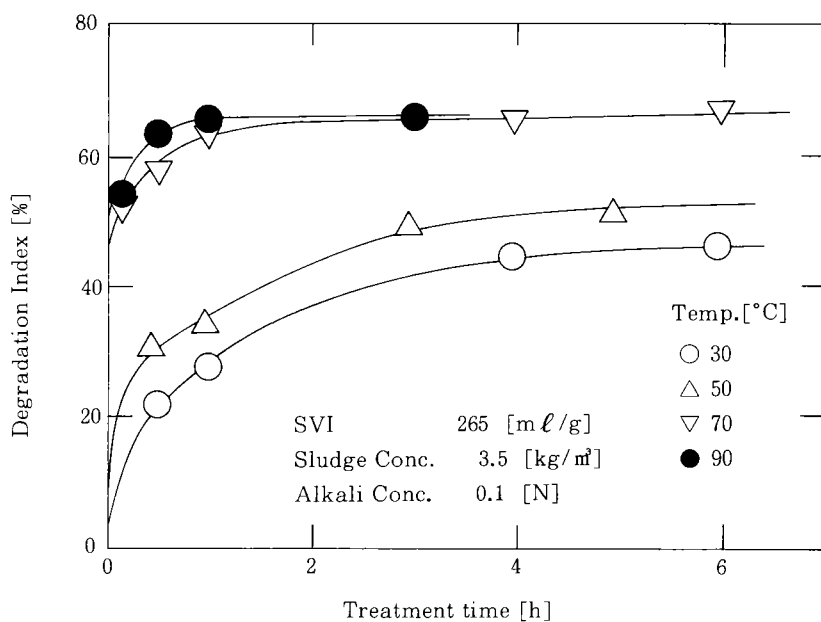


Fig.2 Effect of Temperature

COD in supernatant was increased. It means that a part of solid materials of sludge was transformed to soluble materials. However, degree of degradation was not satisfactory at room temperature.

(2) *Effect of temperature, pressure and sludge conc.*

Fig 2 shows the effect of temperature. Increasing of temperature induces high degradation as well as time required for degradation became shorter at high temperature. Moreover at any temperature, about 50–70% of final degree of degradation occurred within initial 30 min. This means more soluble components have exhausted in earlier period by alkali. Autoclave treatments

(120°C) were examined with and without alkali. The results are shown in Table 1. Autoclave treatment in alkali side was very effective for degradation of sludge, but the cost will be expensive.

Furthermore, effect of sludge concentration on the degradation index is important factor for sludge treatment. Fig.3 shows the influence of sludge concentration on the degradation index. We might say that the maximum concentration of sludge which possible to treat is around 50kg/m³.

(3) *Effect of kinds of microorganisms or SVI*

Degradation index of the floc formation cells (SVI=60–80) was compared to that of the fila-

Table 1 Autoclave treatment

| Addition of alkali | Degradation index after 10 min.<br>(%) |
|--------------------|----------------------------------------|
| none a)            | 21.0                                   |
| added b)           | 79.1                                   |

a),b) SVI: 421 [ml/g], Sludge conc.: 3.65 [kg/m³]  
b) Alkali conc.: 0.1N

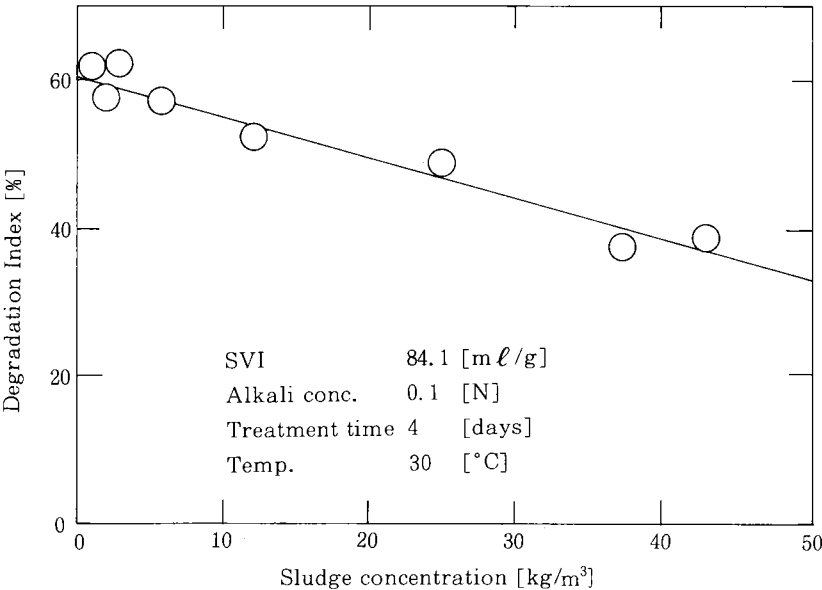


Fig.3 Effect of sludge concentration

Table. 2 Autoclave treatment with and without alkali

|                       | Floc formation cells |           | Filamentous cells  |           |
|-----------------------|----------------------|-----------|--------------------|-----------|
|                       | Alkali & Autoclave   | Autoclave | Alkali & Autoclave | Autoclave |
| pH<br>(—)             | 12.18                | 6.58      | 12.15              | 4.75      |
| Degradation Index (%) | 83.4                 | 32.8      | 61.8               | 25.7      |
| COD (mg/l)            | 993                  | 303       | 703                | 223       |

121 °C,  $1.18 \times 10^5$  pa, 30 min

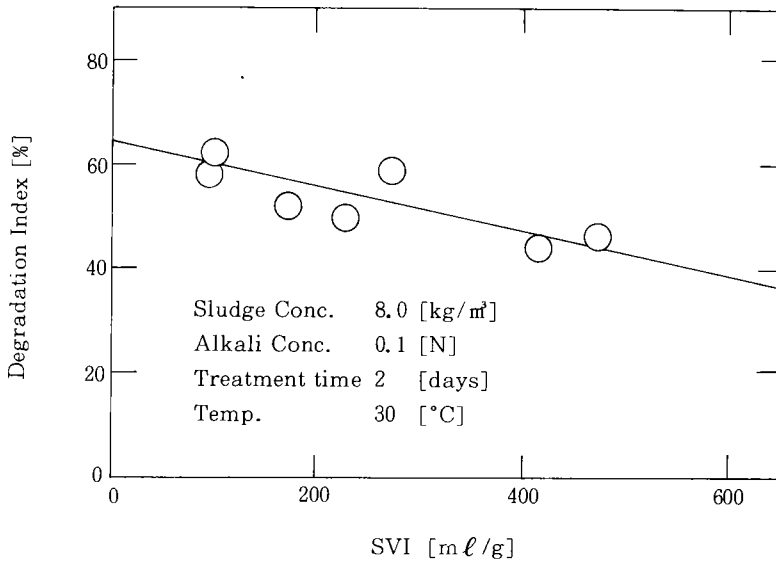


Fig.4 Effect of SVI

mentous bacteria (SVI=189.4) under the conditions of autoclave in alkali side and autoclaved at neutral. The results were shown Table 2. It is clear that the solubility of solid materials of the microorganism was kept higher level in floc formation cells. Then, the effect of SVI to the degradation index was observed. The results were shown in Fig.4. We may say that high SVI

bring about the difficulty of alkali treatment of the sludge.

#### (4) *Anaerobic digestion*

An anaerobic digestion as one of the pretreatment was examined. Wet sludge of 30–50 g to which added the grinding alumina was crushed in a mortar for 50 min. After the grinding operation, pH was adjusted to 9.0 by 3 N NaOH.

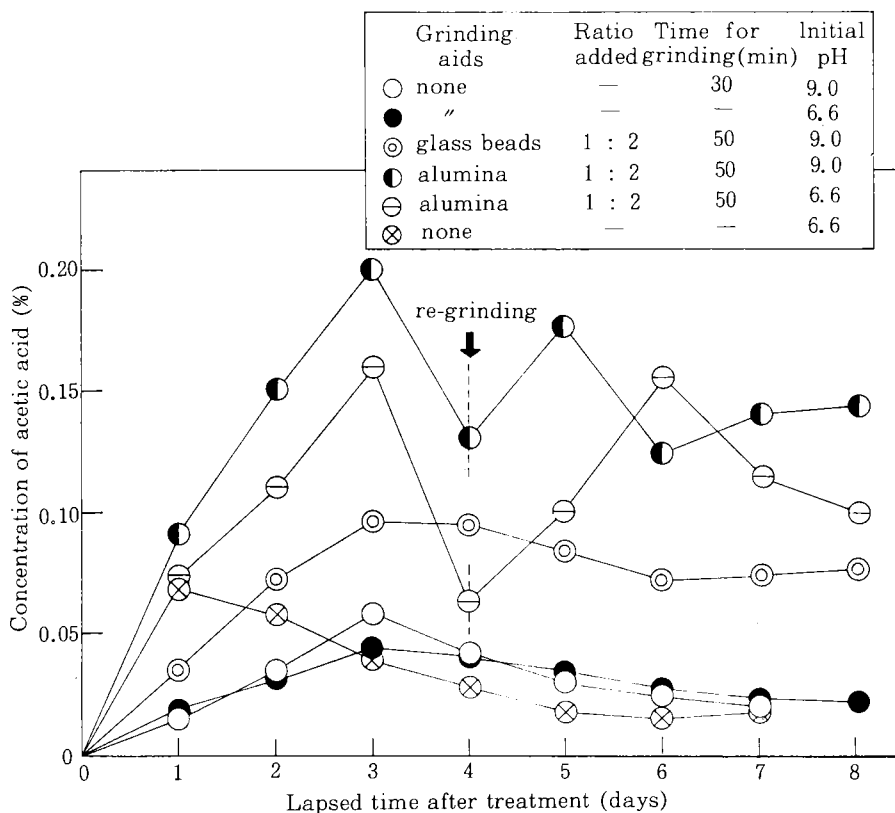


Fig.5 Production of acetic acid from pretreated mixed liquor

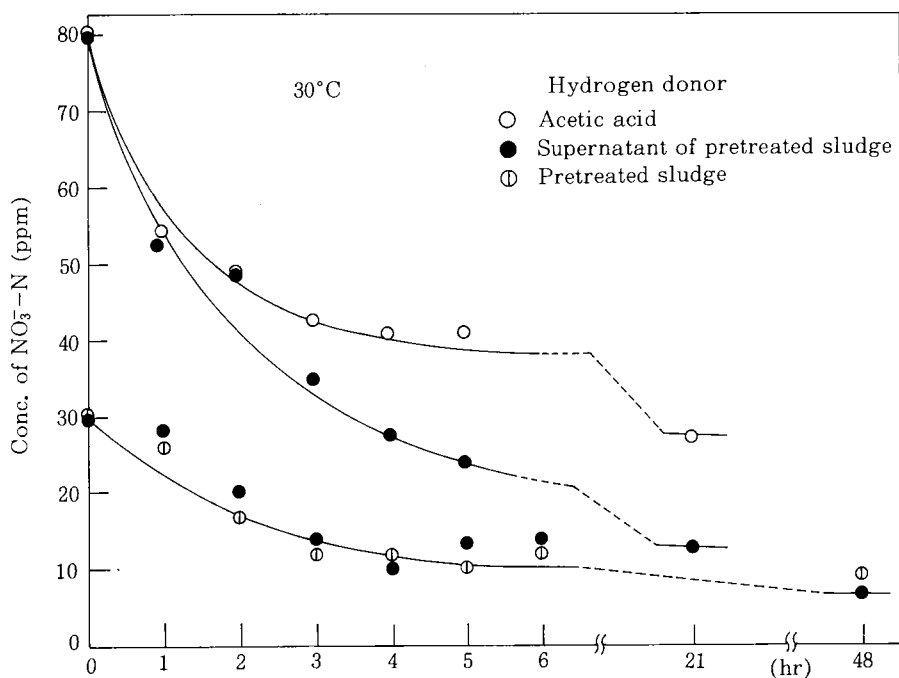


Fig.6 Comparison of effect of hydrogen donors

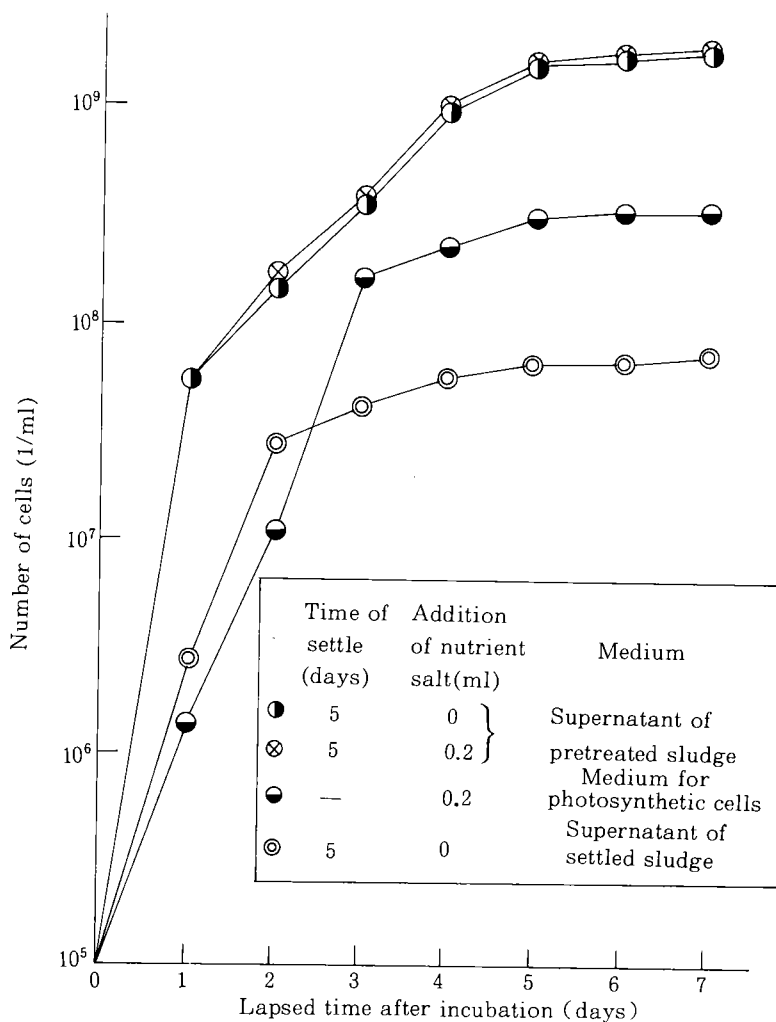


Fig.7 Incubation of photosynthetic cells by the supernatant of pretreated sludge

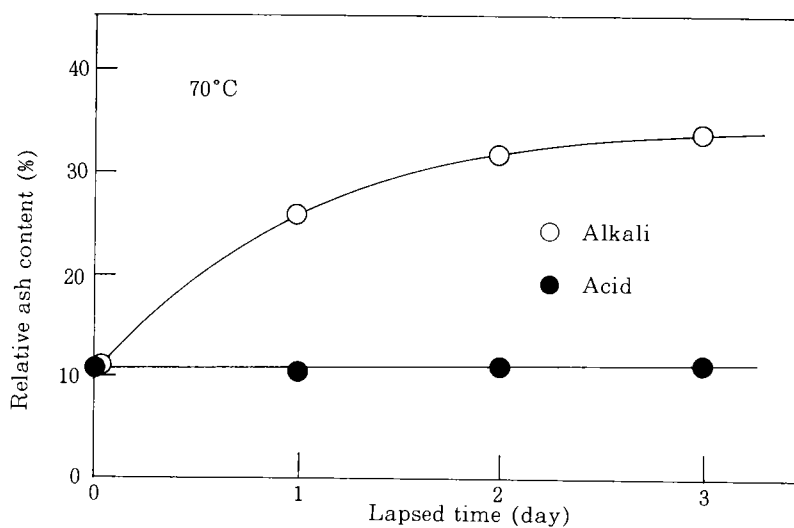


Fig.8 Ash content relative to total solid matter

Thus the mixed liquor was settled at 30°C under the cut off from air by the liquid paraffine layer.

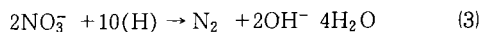
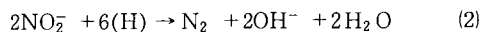
Fig.5 shows the time transition of the acetic acid concentration which was produced in the mixed liquor. Maximum concentration of acetic acid was around 0.2%.

### III. Resourcing of the Excess Sludge

The excess sludge or native sludge does not contain any valuable component and yet latent energy level is very low. However, from the view point of reducing the sludge amount which ultimately must be handled we investigated some utilization of supernatant of alkali treatment.

#### (1) *Hydrogen donor in the denitrification process*

Denitrification reaction as the final stage of nitrogen removal from waste water treatment process, some organic matters are required as hydrogen donor by the following equations.



where (H) means the organic matter as hydrogen donor. Methanol and acetic acid are the most familiar as (H). Fig.6 shows the decreasing of  $\text{NO}_3^- - \text{N}$  concentration by addition of various hydrogen donors. As shown in Fig.6,

### References

1. Hiraoka M. & Yoshino Z.: "Odei Shori Kōgaku (Technology for Sludge Treatment)" Kōdansha(1983)

2. Okumura M., Ariga O. & Sano Y.: Paper presented at 51th Annual meeting of Soc. Chem. Engrs., Japan, p.229(1986)

3. Sano Y., Okumura M., Ariga O. & Otaki K.: Bull. Environ. Conserv., Shinshu Univ., No.8, 44(1986) (in Japanese)

the addition of supernatant was more effective than pure acetic acid.

#### (2) *Incubation of photosynthetic bacteria*

As mentioned in Section II-(4), anaerobic digestion of activated sludge brings on a reasonable amount of low molecular fatty acid especially acetic acid. On the other hand the cell mass of Rhodospseudomonas, one of photosynthetic bacteria, is rich in protein as well as various amino acids. Thus those bacteria are useful as a feed of animals. Moreover, this bacteria take favorably low molecular fatty acid especially acetic acid. Fig.7 shows the growth of bacteria in the pretreated excess sludge supernatant. It is clear that the growth curve of supernatant was the same that of the culture medium for Rhodospseudomonas.

### IV. Ultimate Disposal

In ultimate disposal, there are only two possible ways. One is recalcination on the land and the other is throw away in the sea. Any way, the most important problem is inorganization and stabilization of the organic materials. Fig.8 shows decreasing of relative content defined by the ratio of total solid to inorganic component. The hot alkali may be effective to stabilize of the excess sludge.