Evaluation of cell lysis-cryptic growth method using ozonation for reduction of activated sludge at common effluent treatment plant: A Research

APARNA A. NAVALAKHA[1], G. H. BAN[2]

[1]M.E. Student, Department of Environmental Engineering, L.D. College of Engineering, Gujarat Technological University, Ahmedabad, India

[2]Head of Department, Department of Environmental Engineering, L.D. College of Engineering, Gujarat Technological University, Ahmedabad, India

aparna.navalakha@gmail.com

ABSTRACT:

Due to the fact that CETPs are expanding quickly both in developed countries (due to stringent effluent norms) and developing countries(due to building of new treatment plants), we have to prepare for drastic increase in sludge production.The final disposal of the sludge cost almost 60% of total operational cost of treatment plant. In addition to this, it is necessary to meet today's stringent pollution control norms, thus finding methods to minimize excess of sludge is of growing interest. The paper mainly focuses on waste activated sludge reduction based on cell lysis cryptic growth method using ozonation in sludge line.

KEY WORDS:
Lysis cryptic growth, Ozonation, Mechanism of sludge reduction, Setteability, Anaerobic Digestion

1.0 INTRODUCTION:

In Common Effluent Treatment Plant(CETP) sludge can be produced in two ways; primary which is produced by settleable solids removed from influent wastewater in primary settling ;and secondary which is produced by biological process such as activated sludge process. But among all sludge secondary sludge or excess sludge is of great concern because, during the biological treatment of industrial effluent wastewater, in addition to cell biomass, a large amount of non-biodegradable (inert) solids in particulate form, incoming with the influent raw wastewater, contributes significantly to sludge production. Besides this secondary sludge is difficult to dewater because of high amount of bound water content. The final disposal of this sludge cost 60% of total operational cost of treatment plant. So, considering environmental burden and high expense, finding methods which minimize sludge production is of growing interest. There are many techniques available for reduction of sludge for example lysis cryptic growth method, metabolic uncoupler, endogeneous metabolism, microbial predation, hydrothermal oxidation but the paper mainly focuses on lysis cryptic growth method. The term lysis means breakdown of cell wall or cellular membrane due to some external force and the term cryptic growth means survival of remaining cells on contents lysed from dead cell. When microbial cell undergo lysis or death, the cell contents are released into external environment and provide autochthonous substrate that contributes to the organic loading. Now the few remaining cell will grow either using this autochthonous substrate or using substrate which is already present in wastewater therefore this type of growth is termed as cryptic growth. However once lysed, it becomes easy for the living cells to biodegrade the lysed cells, therefore lysis is the rate-limiting

step of lysis-cryptic growth, and an increase of the lysis efficiency can therefore lead to an overall reduction of sludge production.

The objective of this paper is to evaluate cell lysis cryptic growth method using ozonation for sludge reduction in terms of various parameters including total solids (TS), total suspended solids (TSS), total dissolved solids(TDS), volatile suspended solids (VSS) and settable solids..

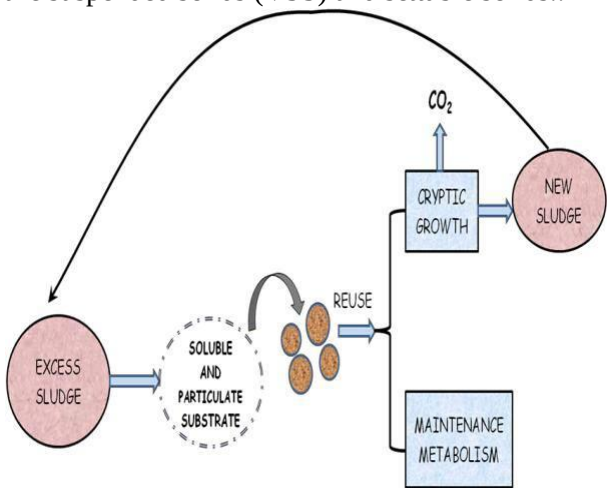

Figure 1 : schematics of cell lysis cryptic growth

2.0 LITERATURE SURVEY:

- Pilot scale ozonation model was developed by K.-H. Ahn et al. (2002) at Gwangju wastewater treatment plant in Gyeonggi-do province, Korea. The system was designed for a waste activated sludge capacity of around 0.2 m^3/d. The system was one of the sequencing batch activated sludge processes, with continuous feeding. The operating cycle consisted of a 30 min anoxic settling phase, a 30 min anaerobic decanting phase, and a 60 min aerobic phase with continuous feeding of actual domestic wastewater into the bottom of the bioreactor. The system was designed with a hydraulic retention time (HRT) of 16.5 hours. Ozone gas flow-rate of 1 m^3/hr at an ozone concentration of 150 g O_3/m^3 was supplied in the reactor. K.-H. Ahn concluded that at an ozone dose of 0.2 g O_3/g DS, the mineralization, carbon source and biosolids residual were 5%, 50% and 45%, respectively, and the composition at 0.5 g O3/g DS changed to 20%, 46% and 34%, respectively. In other words, a significant mass reduction was achieved as the ozone dose was increased while the carbon source generation remained the same.

- Yasui et al. (1996) studied ozone treatment of excess sludge followed by recirculation of the treated sludge into the bioreactor. They have carried out continuous flow experiment in which sludge to be ozonated was drawn continuously from aeration tank and ozonated by batch treatment. Ten runs of recirculation treatment were carried out for a period of 6 weeks.Yasui reported that nearly 35% of treated biomass was mineralized biologically and reduction efficiency was proportional to mass to be treated.

- Richard O. Mines, Jr. and Laura W. Lackey conducted bench-scale ozonation study on waste activated sludge (WAS) in a 10-L, clear PVC, semi-batch, bubble column reactor. Two separate runs were performed on 5-L samples of WAS obtained from the Rocky Creek Wastewater Treatment Plant (WWTP) in Macon, Georgia. Ozone was sparged through a porous diffuser at an application rate of 0.0525 mg O3 min−1 at contact times of 9 days and 12 days, respectively, during Runs #1 and #2. Total solids removals of 50 and 95% Volatile suspended solids removals

of 45 and 99% was observed at an application rate of 0.0525 mg O_3/ min and contact times of 9 days and 12 days respectively.

⇨ S. Akhlaque and S. Farooq performed ozonation in a glass batch reactor with a capacity of 20L. It was 14 in. (356 mm) in diameter and 20 in. (508.mm) long. Ozone gas was supplied at the bottom of the reactor through a medium porosity, fritted glass diffuser. Unused gas was exhausted into the atmosphere through a hood from the top of the reactor. Sludge samples were ozonated continuously in the reactor for 30, 60 and 120 minutes periods. They observed that improvement in settling rate of the sludge for 0, 30, 60 and 120 minutes ozonated samples upto 30 hours, respectively.

⇨ Gholamreza Moussavi developed the system consist annular glass tube with the total volume of 2 L that in each run 1.5 L sludge was poured into it and ozonated. The experiment carried out at different batch runs consisted of 3 several ozone doses between 0.125 to 2 g O_3/ g TS.Ozone-laden gas flow rate was fixed at 1 L/min in which ozone inlet concentration was about 0.45 g/h.He observed that mass reduction of suspended solids in sludge increased with the increasing the rate of ozonation in where the attained destruction efficiency of TSS for ozone doses of 0.125, 0.25, 0.5, 1 and 2 gO_3/g TS was 15.4%, 34.3%, 56.5%, 70.1% and 80.7 %, respectively. The greater the ozone dose, the higher reduction in suspended solids was obtained.

3.0 MATERIALS AND METHODS:

A. LAB SCALE SETUP:

The setup used in this experiment is illustrated in fig. 2.The setup consisted a ozone contactor ,Ozonator with 4 gm/hr capacity ,Oxygen concentrator with flowmeter , tubings and Spray nozzle connected to air pump to breakdown the foams created during ozonation of sludge. Ozone contactor was a cylindrical PVC tube with the total volume of 1.5 L that in each run 1 L sludge was poured into it and ozonated. The experiment carried out at different batch runs consisted of several ozone doses. Ozone-laden gas flow rate was fixed at 1 L/min.

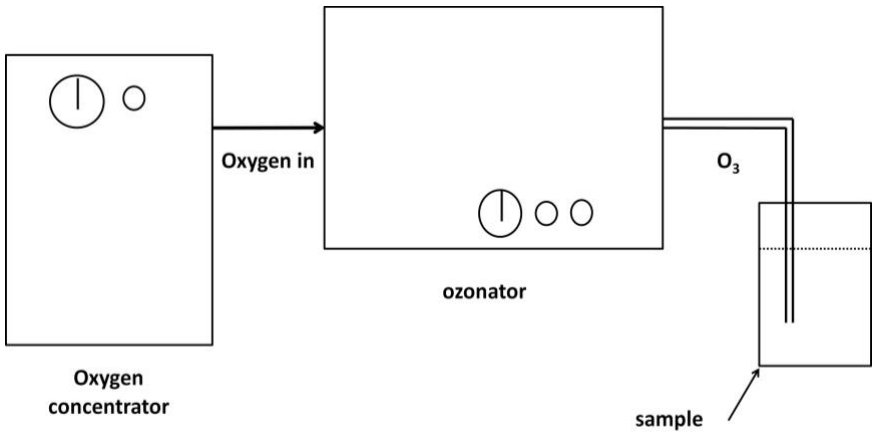

Figure 2 : schematics of lab scale setup

B. EXPERIMENTAL PROCEDURE:

In this experiment, Oxygen was supplied at constant flow of 1 LPM from NIDEK oxygen concentrator at 7 PSI pressure to the ozonator as shown in fig. 3, which eventually generate ozone of 51 mg/l dose and supplied to the PVC reactor at 1 LPM fixed flowrate. Here ozonation was carried out for 5 mins for 5 consecutive days. The analysis of WAS (Waste Activated Sludge) was carried out each day after ozonation.

C.ANALYTICAL METHODS:

In order to evaluate the reduction potential of ozonation , sludge was sampled and analyzed before and after ozonation for total solids (TS), total suspended solids (TSS), total dissolved solids(TDS), volatile suspended solids (VSS) and settable solids. All these measurements were carried out on samples, according to Standard Method.

D.LAB SCALE REACTOR OF CELL LYSIS CRYPIC GROWTH USING OZONATION:

Figure 3: Lab scale setup

4.0 RESULTS AND DISSCUSSION:

The results were taken each day during 5 days period of time and following graphs shows the reduction in different parameters. Fig. 4 shows the reduction in concentration and fig.5 shows the reduction percentage of total solids (TS), total suspended solids (TSS), total dissolved solids (TDS), and volatile suspended solids (VSS) with each day. Total solid reduced from 23.50% to 75.28% in 5 days. Total suspended solids and volatile suspended solids reduced upto 80% in 5 days at fixed ozone dose of 51 mg/L. Solid reduction indicates the mass reduction of sludge and it is because of rupture of cell wall and release of intracellular and extracellular matter.

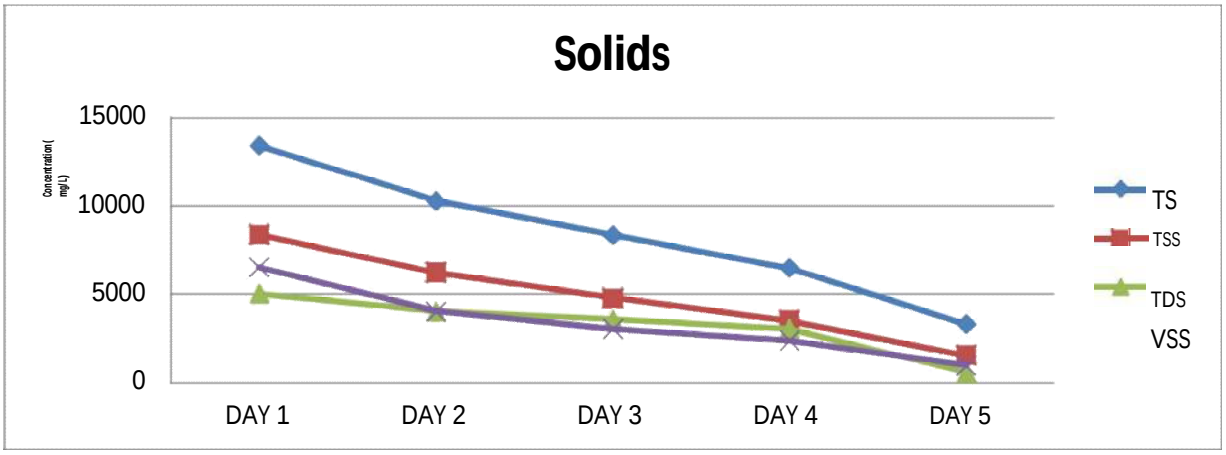

Figure 4: Initial and final characteristics of Waste Activated Sludge

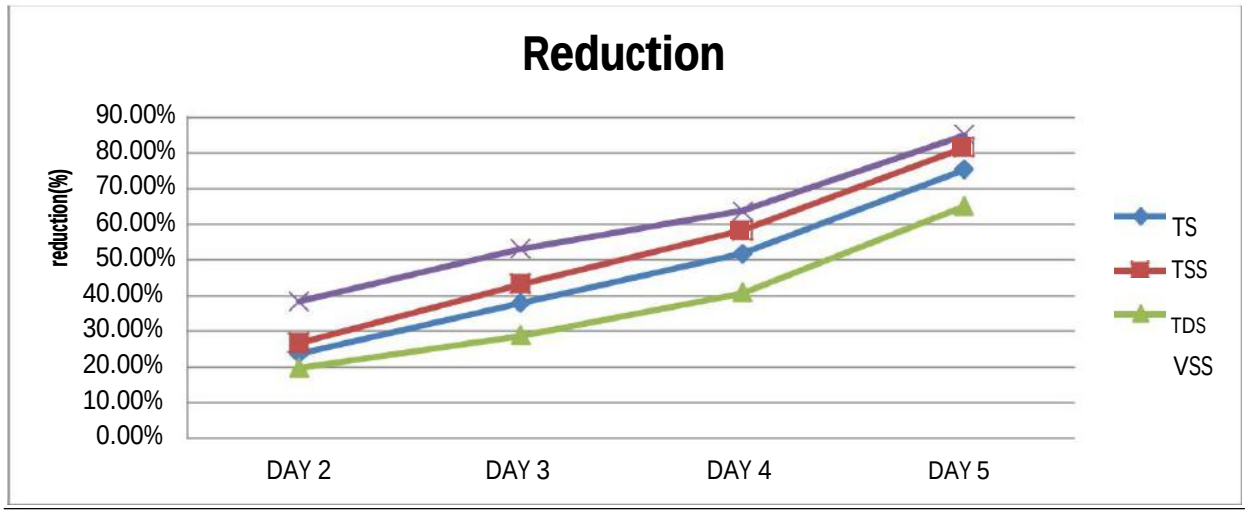

Figure 5: Percent reduction of various parameters

But sludge volume reduction depends upon reduction of settable solids. Fig.6 shows reduction in settable solids after ozonation which increases the settleability of sludge. It will result in improved sedimentation of sludge. After ozonation on each day sludge will settle quickly in thin layer of biosolids and the supernant could be returned to the treatment plant.

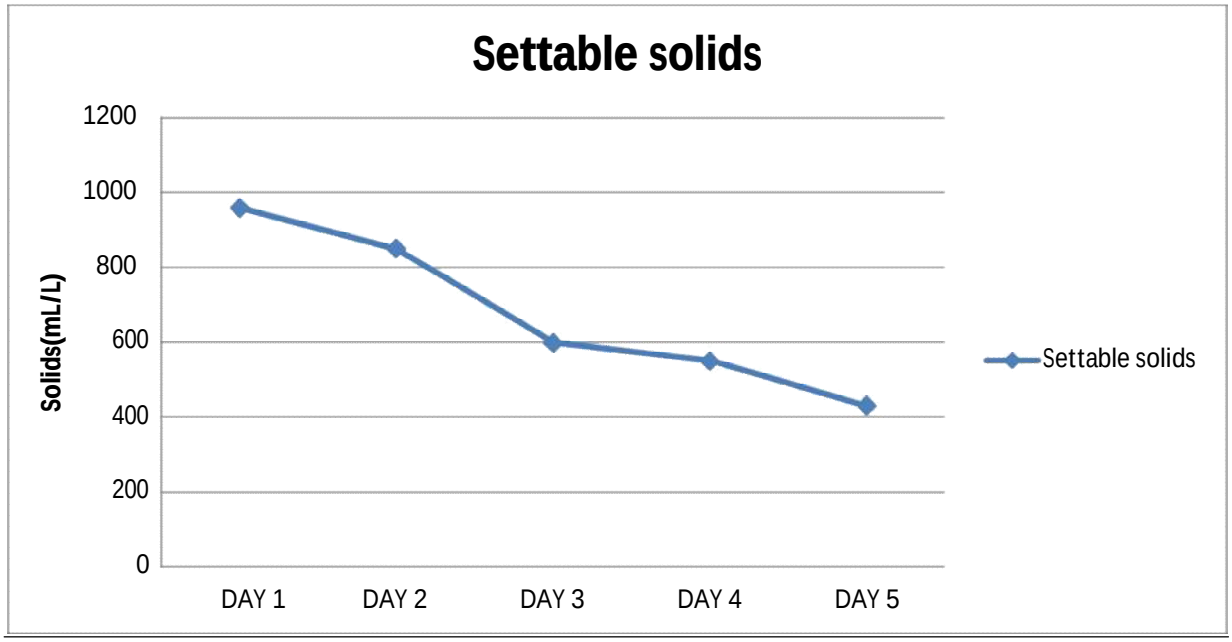

Figure 6: Settable solid reduction

5.0 CONCLUSION:

The research was conducted to study the effect of lysis cryptic growth method using ozonation on volume reduction of sludge and results showed that ozonation can reduce both mass and volume of sludge. The reduction is shown in terms of solids reduction and settleability improvement. The mass reduction in TS, TSS, TDS, VSS was achieved upto 80% within 5 days retention time and only 5 mins of ozonation. Reduction of settable solids was obtained after ozonation which indicate improved dewatering properties and settleability. Study shows that results improve with increasing retention time. As a result of volume reduction of sludge, handling cost will also be reduced, hence ozonation is proved to be effective technique for excess sludge reduction.

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Head of Department, Environmental Engineering, L.D. College of Engineering, Ahmedabad - 15

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