

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The effect of silver nanoparticles on the nitrification process was investigated. The nitrification activities performances were tested with free cells and the entrapped cells. The PVA and CA-entrapped cells were applied. The CA-entrapped cells represented of the natural matrices material while PVA-entrapped cells expressed in the synthetic matrices material. The results were concluded as followed.

1. The effects of initial ammonia (28 mg/L and 70 mg/L) and AgNP (0, 0.05, 0.5, and 5 mg/L) concentrations on nitrification activity were examined. The result presented that the initial ammonia did not play an important role on the nitrification performance. On the other hand, the effect of initial AgNP concentration apparently affected the nitrification process. Higher AgNP concentration inhibited higher nitrification process. The nitrification performance of the wastewater contaminated with AgNPs indicated by OUR, SOUR and activity values ranged from 0.004-0.168 mg-O₂/L/min, 0.010-0.444 mg-O₂/g-VSS/min, and 2.3-98.5 % of control (no AgNPs), respectively.
2. The nitrification performance of the PVA- and CA-entrapped cells were studied. The nitrification performance by the PVA- and CA-entrapped cells indicated by OUR and activity values ranged from 0.0003-0.0144 and 0.0090-0.0240 mg-O₂/L/min and 4.5-87.5 and 64.4-93.8% of control (no AgNPs), respectively. The CA-entrapped cells showed better performances on the nitrification activity than the PVA-entrapped cells. The activities of the large CA-entrapped cell in the tests with AgNP concentration at 5 mg/L were twice higher than those of the PVA-entrapped cells. This could be that CA-entrapment provided better environment for microorganisms resulting in higher nitrification performances. Additionally, AgNPs may interact on Ca²⁺ ion in the CA-entrapped cells causing the fewer amounts of AgNPs in the tests with CA.

3. Large entrapped cells (both PVA- and CA-entrapment) performed better than small entrapped cells. It is because AgNPs penetrated thoroughly in smaller bead.
4. Based on microscopic observation, plenty of microorganisms were observed. Higher AgNPs concentration resulted in more movement of microorganisms.
5. Agglomeration of AgNPs with PVA was observed. This observation supported that better nitrification performance by the PVA entrapped cells compared to free cells was from the matrices physically and chemically protected the microbial cells from AgNPs. Physically, the matrices worked as a wall for entrapping AgNPs. Chemically, the matrices could bind with AgNPs attributing in less cell damage by AgNPs.
6. CA-entrapped cells were protected from AgNPs by physical property. The matrices acted as a wall for entrapping AgNPs.
7. Silver nanoparticles could penetrate into the microbial cells. The cell membrane damaged after treating in wastewater contaminated with AgNPs. The free cell membrane and cytoplasm were more brutal damage compared to cells separated from PVA entrapment.

5.2 Recommendations

The continued works should be performed as follows.

1. The viability of microorganism affected by AgNPs should be performed for both free and entrapped cells.
2. The change in microbial community and effect of AgNPs on individual microorganisms is also needed.
3. The durability of the entrapped cells for long term test should be performed.