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Modelling of Activated Sludge Process

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Modelling of Activated Sludge Proces

Anvita Sharma [α] & Himanshu Choksi [σ]

Abstract - In this report, I have used commercial matlab software for activated sludge process. Have included various types of activation process, and then done simulation of a simple fermenter and activated sludge processer used in activated sludge process included the future developments in activated sludge process.

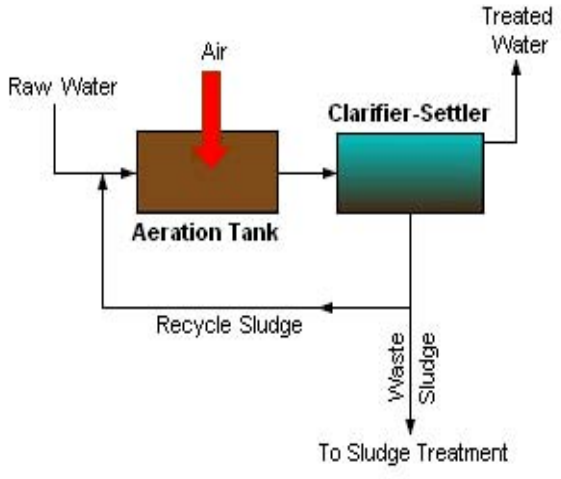
I. Introduction

a) Activated Sludge [18]

Activated sludge process is a highly efficient system for the aerobic biological treatment of industrial or municipal wastes. The process depends on the use of a high concentration of microorganisms in the form of floc, which is kept in suspension by agitation. Agitation is provided either by mechanical means or by aeration.

In this process, a portion of the separated sludge along with the native population of living microorganisms is added to the incoming effluent as inoculums. This added sludge is often referred to as activated sludge and carries out the actual oxidation. Thus, a constant microbial population is maintained in the activated sludge tank.

The activated sludge tank is simple in design. It is an oblong deep tank, provided with an inlet at the top of one end and an outlet at the bottom of the other end. Aeration is provided either by an air diffuser located at the bottom of the tank or by agitators at the surface of waters along both sides of the tank.



Author α σ : School of Technology, Pandit Deendayal Petroleum University, Gandhinagar.

b) Modeling and Simulation[19]

- Modeling
  - To realistically simulates a true plant
  - To evaluate controllers and control strategies
- IAWQ's Activated Sludge Model No. 1
  - Most widely used model
  - Developed by Henze et al. (1987)
  - Used to model each zone of bioreactor.
- The bioreactor model describes
  - Removal of organic matter
  - Nitrification
  - Denitrification.

II. Simplified System

a) Constants

- mu_m=0.48;
- k_m=1.2;
- p_m=50;
- k_i=22;
- alpha =2.2;
- bita =0.2;
- y_x_s=0.4;
- x_s= 7.3059;
- s_ss=5.1340;
- p_ss=25.0081;
- d_ss=0.20; % DILUTION RATE
- sf_ss=30; % SUBSTRATE CONCENTRATION

b) Related Equations

- d = d_ss+ 0.016*u(1) ;

% actual input dilution rate at given instance

- s = sf_ss + 2.3*u(2) ;

% Actual substrate concentration at given instance

- mu_m1=mu_m;%+u(3);

% maximum specific growth rate at given instance

- num=(1-(x(3)/p_m))*x(2);
- den=k_m+x(2)+((x(2)^2)/k_i);
- mu=mu_m1*(num)/den;

c) Differential Equations

- (dx1/dt) = -d*x (1) +mu*x (1);
- (dx2/dt) = d*(s-x(2))-mu*x(1)/y_x_s
- (dx3/dt) = -d*x(3)+(alpha*mu + bita)*x(1) ;

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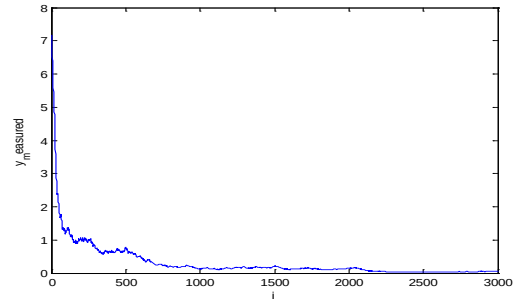
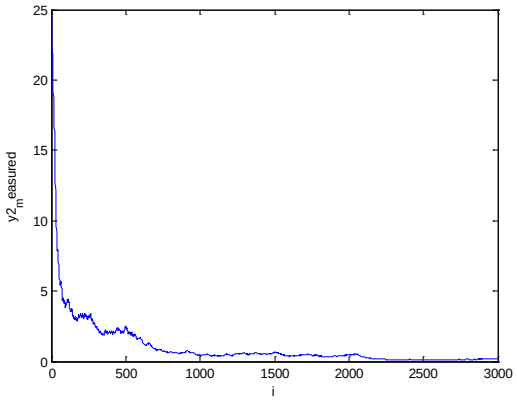
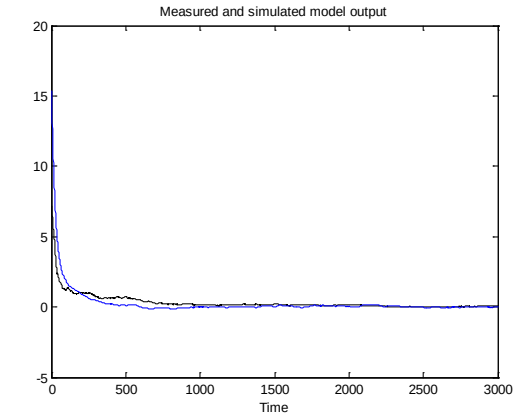
III. Results of The Fermenter System





a) After Performing Identification



b) Study Related to the Actual Activated Sludge System[19]

Exceptions

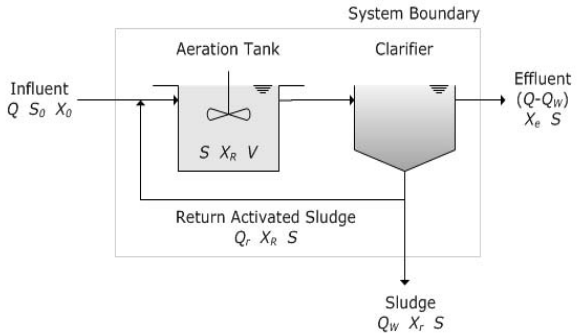
- S_I (inert soluble organic matter) and S_{ALK} (total alkalinity) are not included.
- The inert ($X_{I,IAWQ}$) and particulate ($X_{P,IAWQ}$) matter are combined into one variable

Hence $X_I = X_{I,IAWQ} + X_{P,IAWQ}$.

- (S_O) dissolved oxygen describes the oxygen transfer.
- K_La is the oxygen transfer function
- u is the airflow rate
- $S_{O,sat}$ is the saturated dissolved oxygen concentration.

Parameters [19]

- S_{NH}(t) soluble ammonium nitrogen
- S_{NO}(t) soluble nitrate nitrogen
- S_{ND}(t) soluble biodegradable organic nitrogen
- S_O(t) dissolved oxygen
- S_S(t) soluble substrate
- $X_{B,A}$(t) autotrophic biomass
- $X_{B,H}$(t) heterotrophic biomass
- X_{ND}(t) particulate biodegradable organic nitrogen
- X_S(t) slowly biodegradable substrate
- X_I (t) particulate matter & products

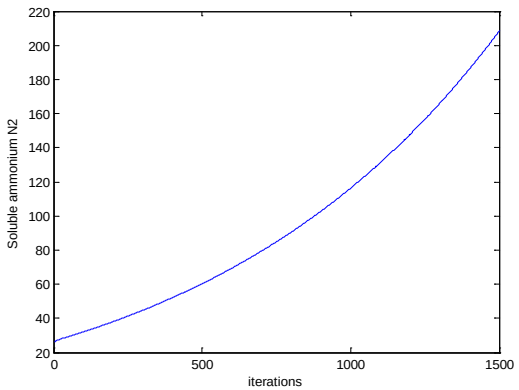


c) Default Inlet Concentration[19]

STATE	mg/l
S_S	60
X_I	50
X_S	100
$X_{B,H}$	25
$X_{B,A}$	0
S_O	0
S_{NO}	1
S_{NH}	25
S_{ND}	2
X_{ND}	6

IV. Results of Simulation

a) Without using Do-Controller



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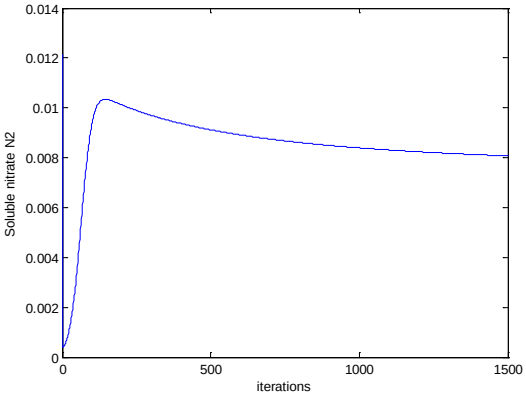

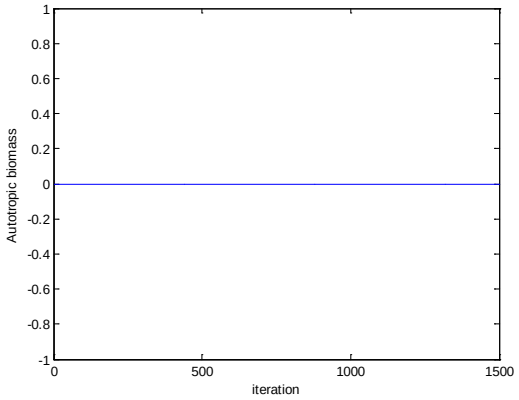

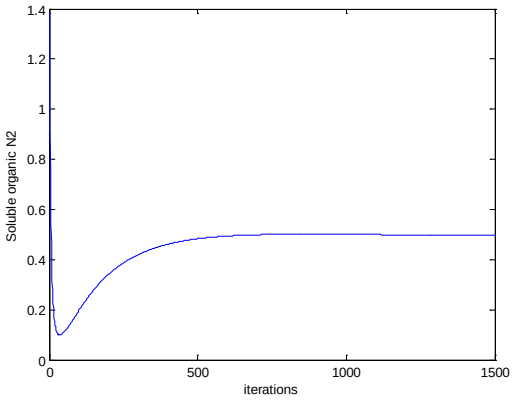

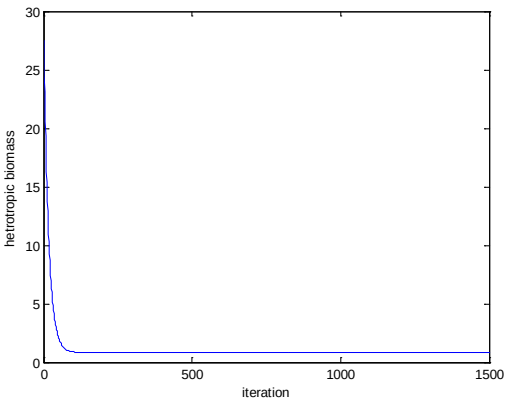

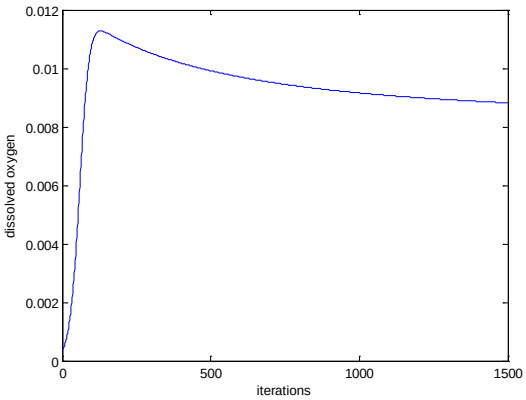

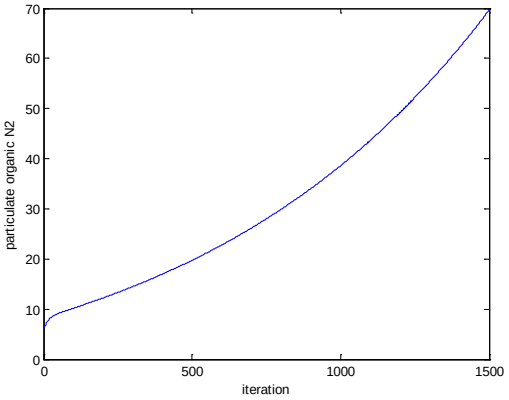

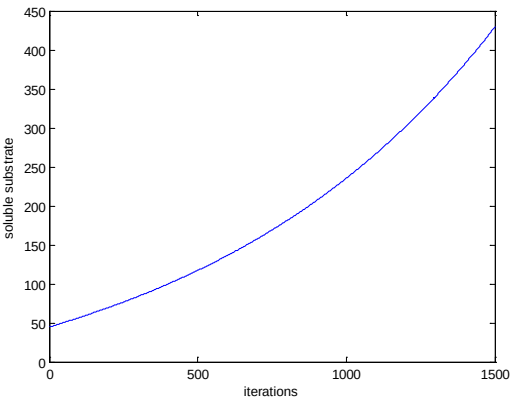

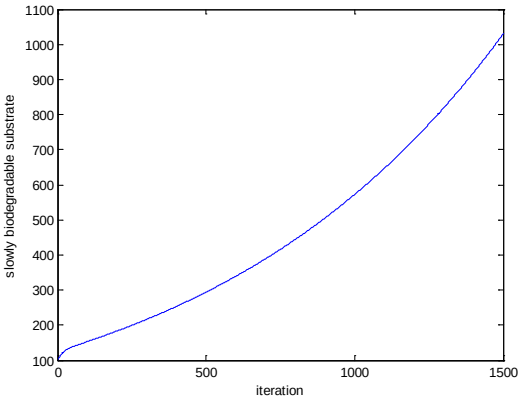

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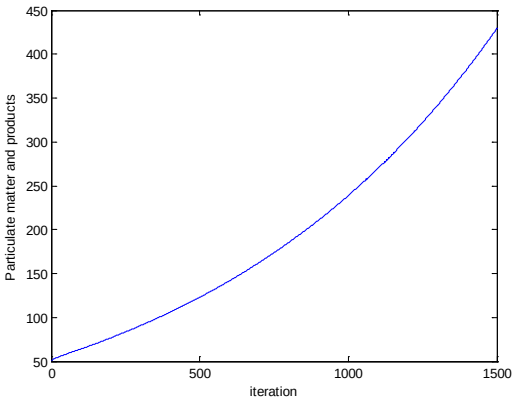
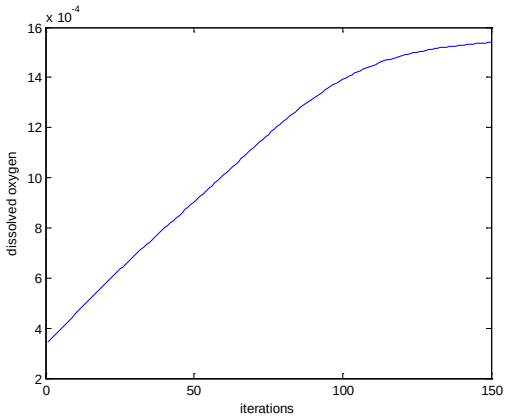
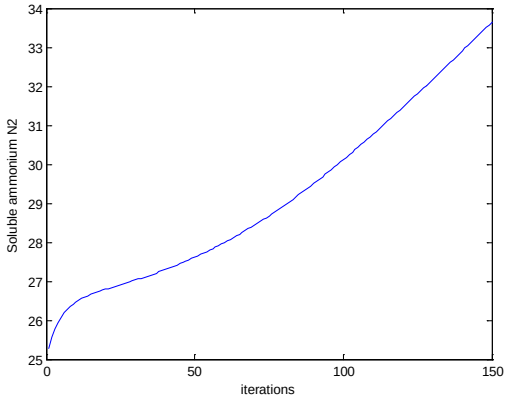
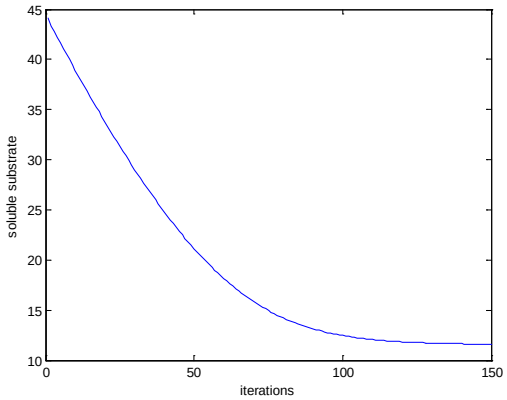
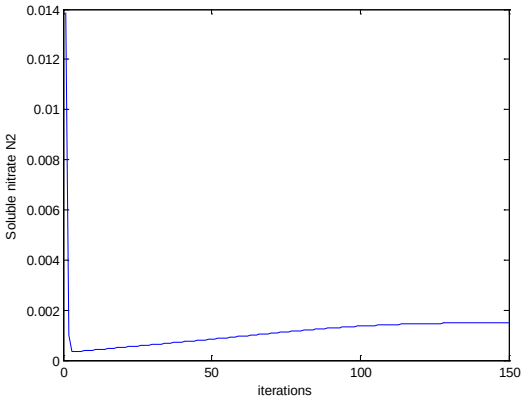


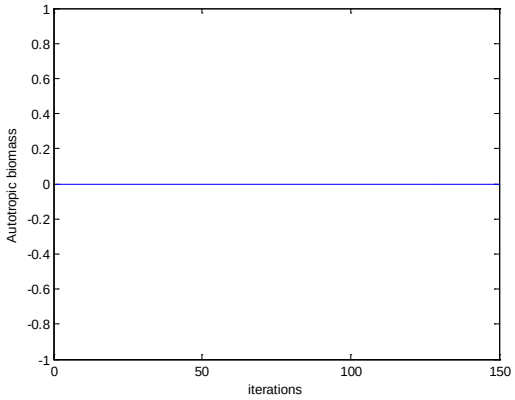


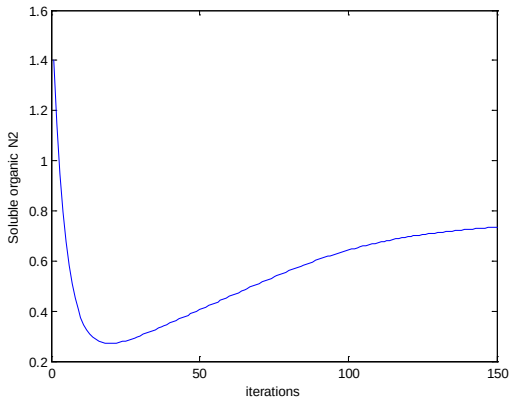
b) When using A P Controller to Do-Concentration

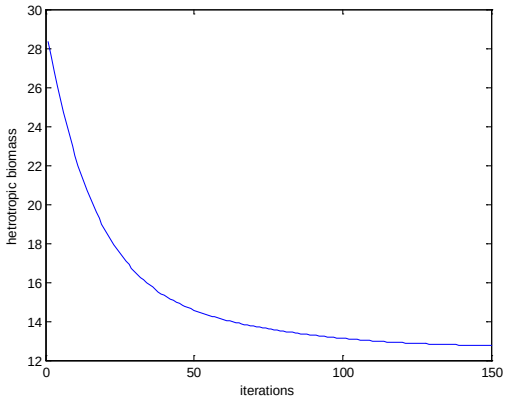












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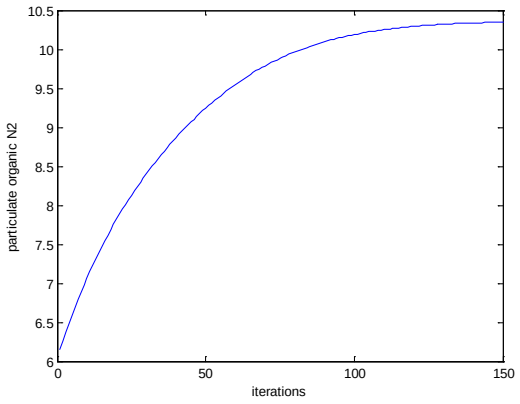

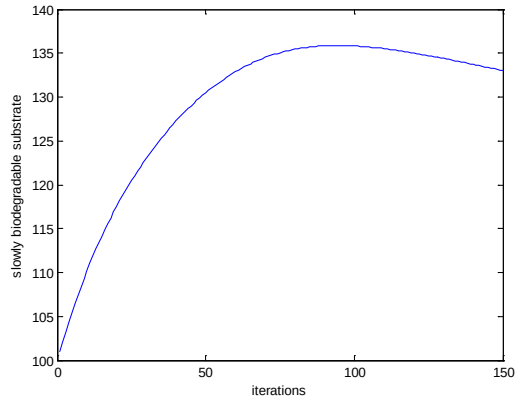

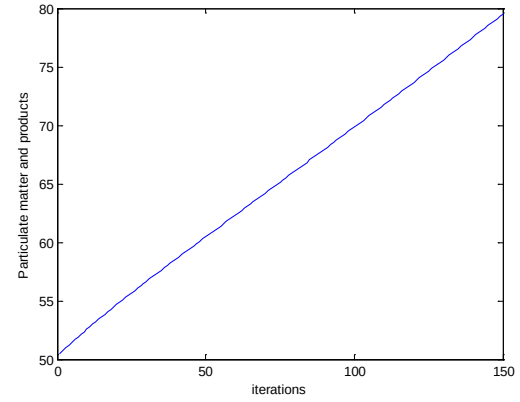

V. Conclusion

1. The pilot plant has been a very fruitful tool in studying various aspects of the activated sludge process, ranging from innovative operating modes microbiological studies to advanced control and estimation schemes.
2. New methods have been easy and inexpensive to test. It is, however, important to observe that the operation of a pilot plant with an extensive instrumentation is quite demanding in terms of maintenance.
3. The results from the pilot plant studies have given important guidelines for full scale plant design and operation.
4. The developed control strategies show that an increased automation can lead to energy savings and reduced consumption of chemicals.
5. The simulation model has been a very useful tool for evaluation of all the different controllers and control strategies.
6. Much time and work have been saved by first doing simulations prior to practical tests in the pilot plant.

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