Global Journal of Researches in Engineering
Chemical Engineering
Volume 13 Issue 1 Version 1.0 Year 2013
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

Modelling of Activated Sludge Process

By Anvita Sharma & Himanshu Choksi
Pandit Deendayal Petroleum University

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.

GJRE-C Classification : JEL Code: 090409

Strictly as per the compliance and regulations of :

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.

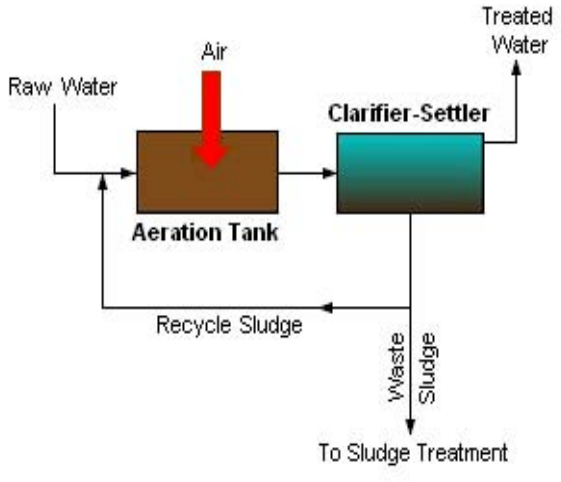
I. Introduction

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);

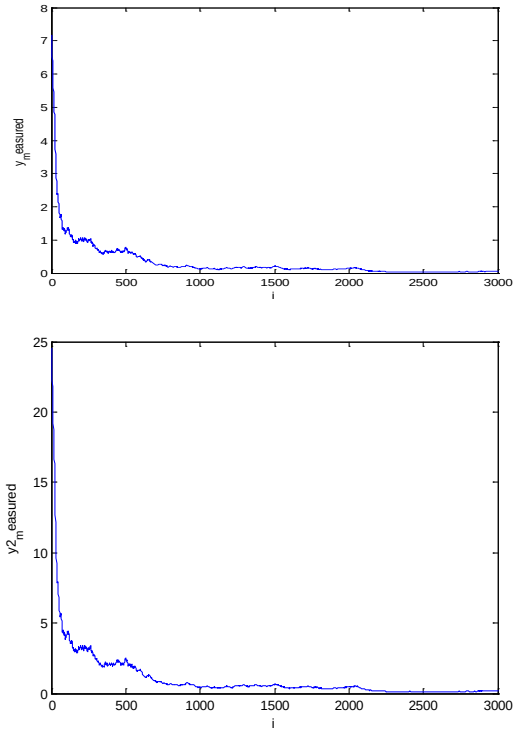
% maximum specific growth rate at given instance

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

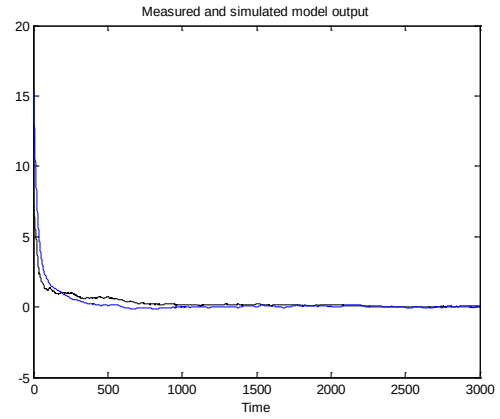
c) Differential Equations

- (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) ;

III. Results of The Fermenter System



a) After Performing Identification



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

Exceptions

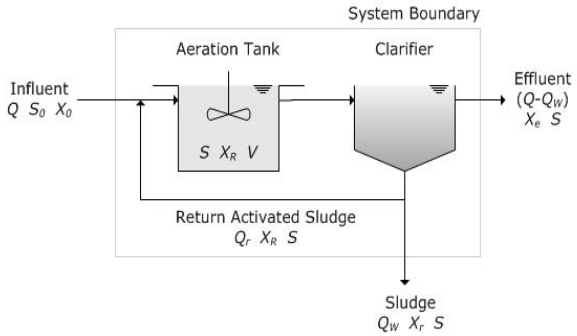
- S_I (inert soluble organic matter) and S_{ALK} (total alkalinity) are not included.
- The inert ($X_{I,IAWQ}$) and particulate ($X_{P,IAWQ}$) matter are combined into one variable

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

- (S_O) dissolved oxygen describes the oxygen transfer.
- $K_L a$ 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

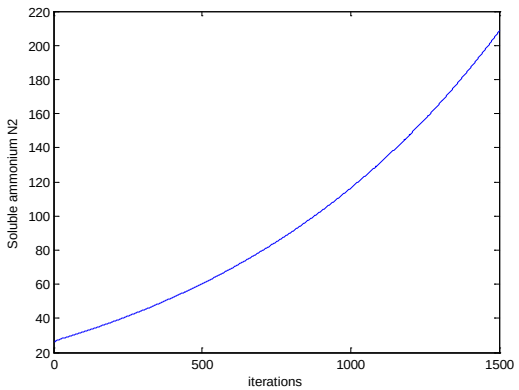


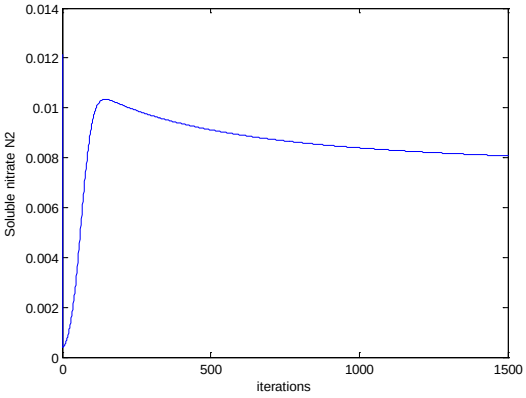
c) Default Inlet Concentration[19]

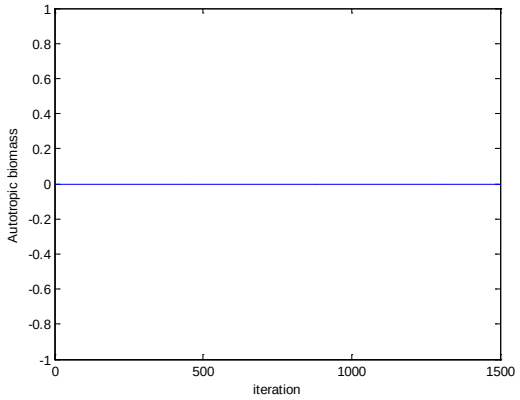
STATE	mg/l
S_S	60
X_I	50
X_S	100
$X_{B,H}$	25
$X_{B,A}$	0
S_O	0
S_{NO}	1
S_{NH}	25
S_{ND}	2
X_{ND}	6

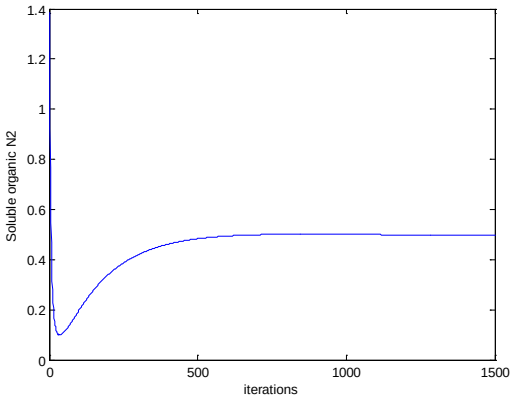
IV. Results of Simulation

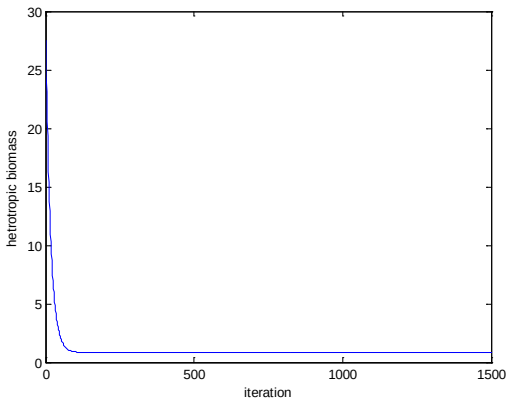
a) Without using Do-Controller

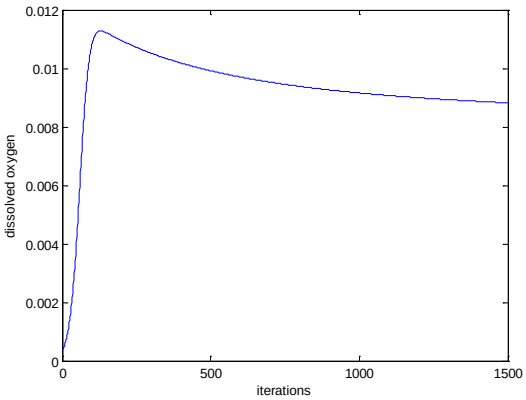


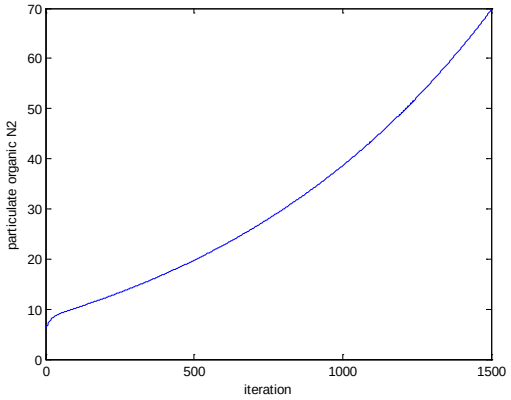


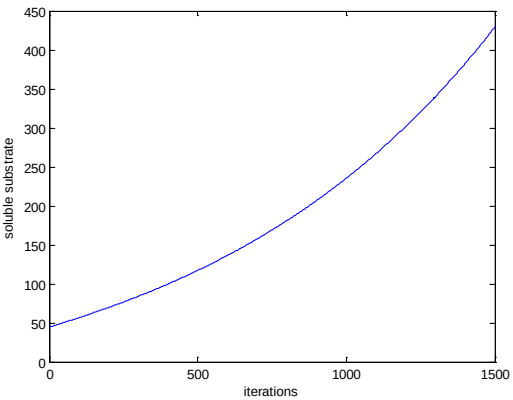


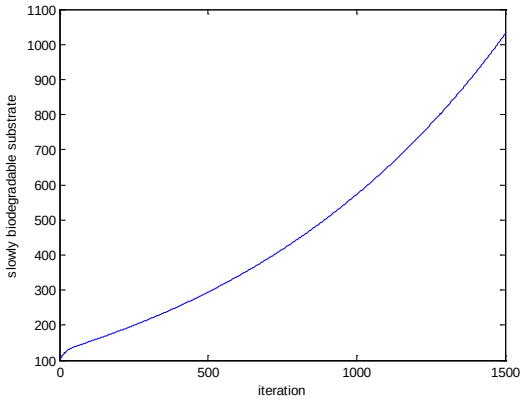


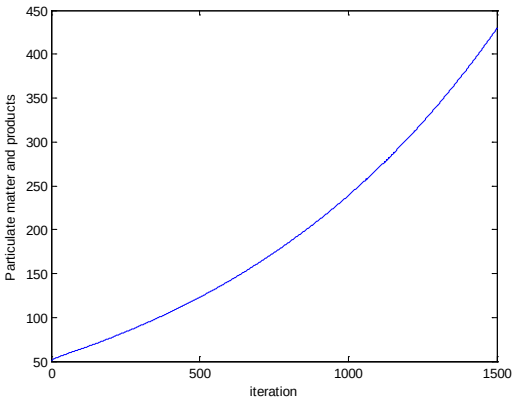


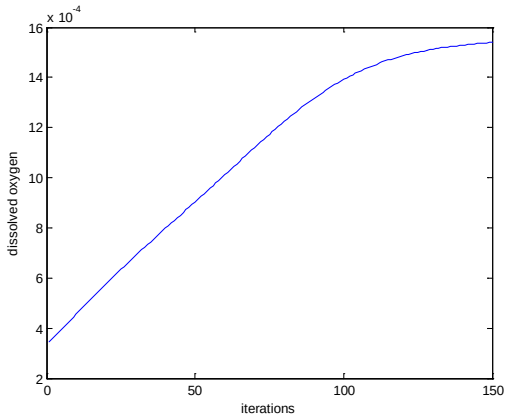




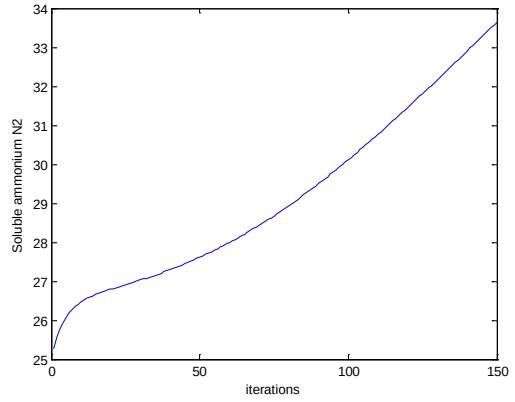


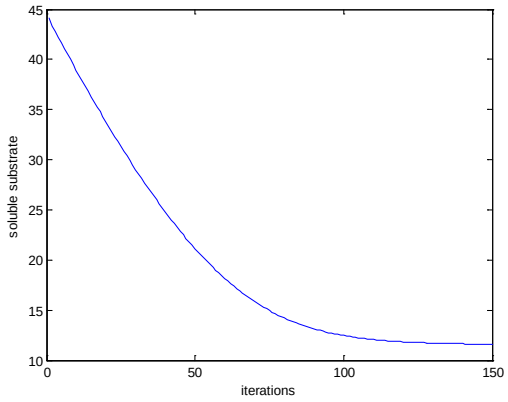


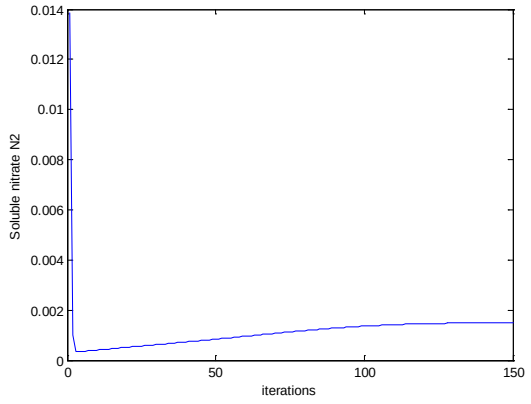


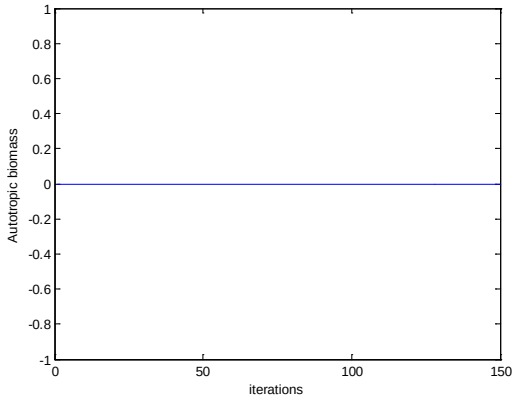


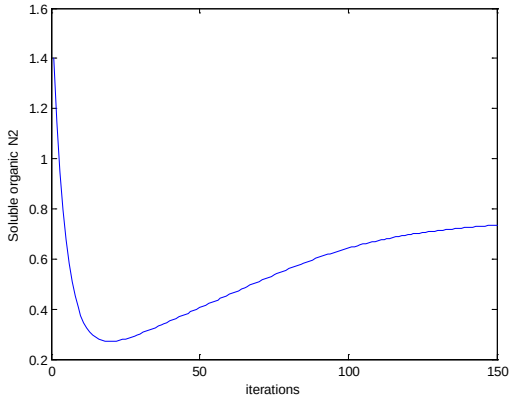
b) When using A P Controller to Do-Concentration

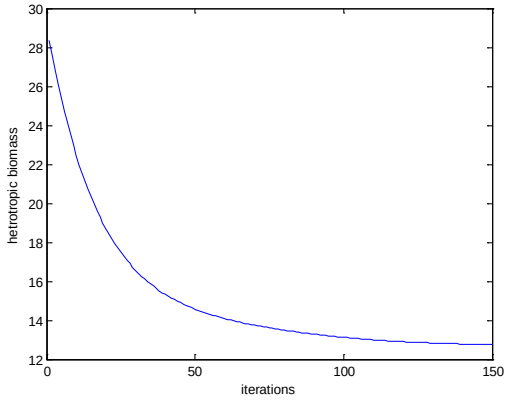


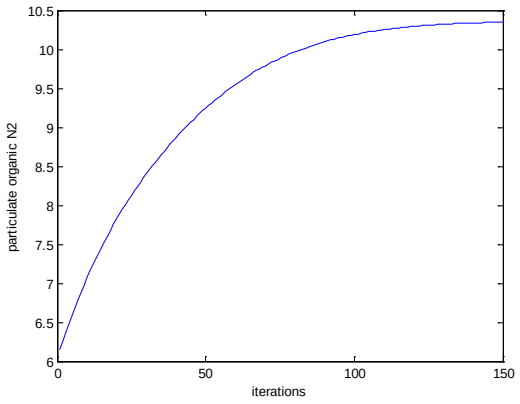


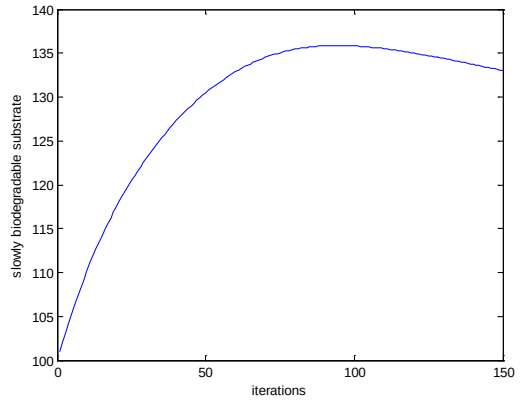


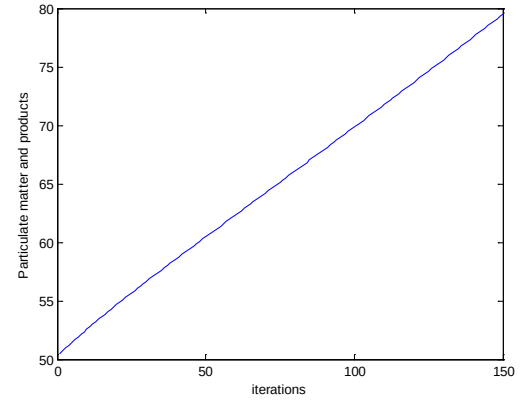












V. Conclusion

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.

References Références Referencias

1. **Adaptive control of nitrate level in an activated sludge process.** Exman, P. Samuelsson and B. Carlsson; water Science and Technology vol 47 No 11 pp 137-144; IWA Publishing 2003
2. **Benchmarking combined biological phosphorous and nitrogen removal waste water treatment processes.:** krist v. Gernaey, sten. B. Jorgensen. Control Engineering Practice 12 (2004) 357-373
3. **Benchmarking procedure for full scale activated sludge plants: a. Abusam, K. J. Keesaman, H. Spanjers, G. Van straten. Control Engineering Practice 12(2004)315-322.**
4. **Biotechnology Advances** Volume 19, Issue 2, 1 April 2001, Pages 97-107
5. **Control of an alternating aerobic-anoxic activated skudge system- part 2:** optimization using a linerized model by Hyunook Kim, T.J. Mcavoy, J.S. Anderson, O.J.Hao Control Engineering Practice 8 (2000) 279-289
6. **Control and Estimation Strategies Applied to Activated Sludge Processes;** Carl-Fredrik Lindberg; 1997
7. **Chemically reduced excess sludge production in the activated sludge process** Chemos-phere, Volume 50, Issue 1, January 2003, Pages 1-7 YuLiu
8. **Dynamic kinetic model of the activated sludge process;** L.M.Chase; FMC Corporation, Central Engineering Laboratories, Santa Clara, California 95052
9. **Full-scale operation of a novel activated sludge process without excess sludge production** Water Science and Technology, Volume 34, Issues 3-4, 1996, Pages 395-404 H. Yasui, K. Nakamura, S. Sakuma, M. Iwasaki, Y. Sakai
10. **Milestones in the Development of the Activated-Sludge Process Over the Past y, Eighty Years** (Abridged)P. F. Cooper, BTech, MSc, CEng, MIChemE (Fellow)*, A. L. Downing, FEng, DSc, MA, BSc, FIChemE, FIBiol (Hon Fellow)**
11. **Minimization of excess sludge production by increase of oxygen concentration in activated sludge flocs; experimental and theoretical approach** Water Research, Volume 34, Issue 1, 1 January 2000, Pages 139-146 B. Abbassi, S. Dullstein, N. Räbiger

12. **Modeling and Control of Oxygen Transfer in High Purity Oxygen Activated Sludge Process;** J. Envir. Engrg. Volume 129, Issue 5, pp. 402-411 (May 2003)
13. **'Single and combined effects of nickel (Ni (II)) and cobalt (Co (II)) ions on activated sludge and on other aerobic microorganisms: A review' by** Petros Gikas in journal of hazardous material 159 (2008)187-203.
14. **Strategy for minimization of excess sludge production from the activated sludge process;** Yu Liu and Joo-Hwa Tay; Environmental Engineering Research Center, School of Civil and Structural Engineering, Nanyang Technological University, 50 Nanyang Avenue, Singapore 639798, Singapore
15. Metcalf and Eddy. Waste water Engineering. Tata Mc. Graw Hill. 4th edition
16. **2nd Generation Autothermal Thermophilic Aerobic Digestion: Conceptual Issues and Process Advancements** – by Kevin L. Staton and James E. Alleman Richard L. Pressley and Jim Eloff.