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Feedback Linearizing Control For Recycled Wastewater Treatment

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Abstract

Among the new technology in during 1970s, biotechnology has attracted the most attention and has proved to be susceptible to enormous wealth and influence in all sectors of the economy. In this process the biological material to be used as parsering contaminants in the raw waste or raw materials from the ground. Microorganisms in contact with organic matter in the wastewater can be used as feed. So the main point in the design process apply understand biological processes or the type of organism's biochemical activities. The main purpose of controlling, maintain the wastewater treatment plant at a satisfactory level, despite the changes the inflow and concentration of pollutants. the most important part is controlled through an aerator.

Keywords*:* Aeration, sedimentation construction, recovery rates, sludge activated, linear feedback mechanism

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I. BIOLOGICAL PROCESSES IN WASTEWATER

Among the advanced technologies, biological process have progressed rapidly and developed. In this process, the biological material are being used as degrading contaminants in the raw waste or raw materials from the ground .In environmental engineering, biotechnology processes for the recycling of waste water, are used as a gas and waste disposal[1].This process also can produce biogas and hydrogen as new energy sources. In engineering the environment to avoid environmental pollution of the activated sludge, trickling filters, biological trickling filters, oxidation ponds, anaerobic recycling, composting units and biogas reactors Tvrgstrdhay technologies to recycle waste[2].

Microorganisms in contact with organic matter in the wastewater can be used as feed [1]. So the main point in the design of biological processes or the type of process, are being used as a biochemical activity of organisms [2].

II.Micro-organisms

Microbial fermentation is a process in which population of microorganisms have grown by using a certain food, and favorable environmental conditions (temperature, pressure, PH, to stroke, aeration, etc.) [9]. The process through metabolic activity of microorganisms raw materials, mainly are converted into organic compounds.The most important components of the environment are as follows:

Substrates for the growth of microorganisms or as part of the raw materials, are for essential production. The substrate consists mainly of a carbon source (glucose, ethanol, methane, etc.) and sometimes nitrogen[10].

The final products are used for purposes such as agriculture, food (oil, cheese, beer, wine, etc.), chemicals (solvents, enzymes, amino acids, etc.), pharmaceuticals (antibiotics, hormones , vitamins, etc.) or energy (ethanol, biogas, etc.) are used[3].The main objective is the growth of microorganisms. For example, in the production of sourdough bread goal is microbial growth. metabolic Production synthesis is a desired metabolites (such as ethanol or penicillin) using microorganisms[12].

The objective of the environmental analysis process are substrates and raw materials. From the perspective of mathematical modeling, biological reactors can be divided into two main categories [4].Disruptive tank reactor (STR), in which the reaction medium is homogeneous and the reaction is described by ordinary differential equations. Spatial concentration gradient such as fixed bed reactors, fluidized bed, in which the reaction in the form of differential is described equations with partial derivatives. According to the structure of activated aerobic sludge wastewater systems, reactor model can be defined in this article is the first in the category.

III. Modeling biological aerobic wastewater process by using activated sludge

The main purpose of controlling is to maintain the wastewater treatment plant at a satisfactory level ,despite the changes, the inflow and concentration of pollutants. In aerobic biological treatment process effluents regulated pollutant concentrations and the amount of dissolved oxygen in the water. The biomass recovery including flow rate and inlet air rate, the control variables[5].

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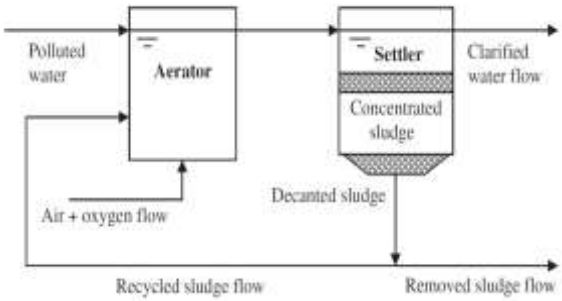

Figure 1: Schematic view of biological wastewater treatment with activated sludge process

$$\dot{X}(t) = \mu(t)X - D(1+r)X + rDX_r \quad (1)$$

$$\dot{S}_1(t) = -\left(\frac{\mu(t)}{Y_1}\right)X - D(1+r)S_1 + DS_{1,in} \quad (2)$$

$$\dot{S}_2(t) = -\left(\frac{\mu(t)}{Y_2}\right)X - D(1+r)S_2 + DS_{2,in} \quad (3)$$

$$\dot{O}(t) = -k_0\left(\frac{\mu(t)}{Y_1} + \frac{\mu(t)}{Y_2}\right)X - D(1+r)O + \alpha W_0(O_{max} - O) + DO_{in} \quad (4)$$

$$\dot{X}_r(t) = D(1+r)X - D(\beta + r)X_r \quad (5)$$

Where X, S1, S2,O and Xr the concentration of biomass (activated sludge) in the reactor, pollutant 1 pollutant 2, dissolved oxygen and biomass was recovered, and O max is the maximum concentration of dissolved oxygen. D is the dilution rate by dividing the volume flow rate of feed F in aerators V can be achieved[6]. The specific growth rate μ, Y1 and Y2 coefficients S1 consumption and emissions S2, r the rate of sludge recovered, β adjusted rate of sludge[8], k0 fixed model,W0 aeration rate and oxygen, If the state vector friendly process as ξ = [X S1 S2 O Xr], φ = μ (.), X and the reaction rate environment[11].

$$v = \begin{bmatrix} 0 \\ DS_{1,in} \\ DS_{2,in} \\ DO_{in} + \alpha W_O(O_{max} - O) \\ 0 \end{bmatrix} \quad (6)$$

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$$K = \begin{bmatrix} 1 \\ -\frac{1}{Y_1} \\ -\frac{1}{Y_2} \\ -k_o\left(\frac{1}{Y_1}+\frac{1}{Y_2}\right) \\ 0 \end{bmatrix} \quad (7)$$

$$\dot{\xi} = K\varphi(\xi) - \bar{D}\xi + v \quad (8)$$

IV: Dynamic model of environmental parameters of aerobic wastewater treatment process by using activated sludge

Aerobic activated sludge biological treatment process parameters for control system and design and simulation applied in Table 1:

Table 1: aerobic activated sludge treatment process parameters

unit	Parameter names
0.25 h^{-1}	μ^0_{max}
100 mg/l	K_{S_1}
100 mg/l	K_{S_2}
2 mg/l	K_O
0.5	Y_1
4	Y_2
8 mg/l	O_{in}
10 mg/l	O_{max}

V:Linear Feedback friendly construction aerobic wastewater process by using activated sludge

The concentration of pollutants that P = S1 + S2 defined and the concentration of dissolved oxygen in aeration O, a controlled output variables that make up the vector is written to y = [P O] ^ T. Knowing that in practice input current varies with time and concentration of

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contaminants in the stream usually time-varying and can not measure the rate of recovery of biomass r and air flow WO as control inputs ,we consider that vector format as u = [r W_O] ^ T. It can be seen that the process control environment with a multivariable control problem we face square with two input and two outputs [7].

Since the model (8) relative degrees both controlled variable P and O is equal to a dynamic output y can be written as follows:

$$\dot{y} = f(K, \varphi, \xi) + g(\xi) = A(\xi) + \Phi^T(\xi)\rho + B(\xi)u \quad (9)$$

$$\Phi^T(\xi) = \begin{bmatrix} -\left(\frac{1}{Y_1} + \frac{1}{Y_2}\right) \\ -k_O\left(\frac{1}{Y_1} + \frac{1}{Y_2}\right) \end{bmatrix} \quad (10)$$

$$\mu(t) = \mu_{\max} \frac{S_1(t)}{K_{S_1} + S_1(t)} \frac{S_2(t)}{K_{S_2} + S_2(t)} \frac{O(t)}{K_O + O(t)} \quad (11)$$

Feedback linearization multivariate control law maker is as follows:

$$u = B(\xi)^{-1}[\Lambda(y^* - y) - A(\xi) - \Phi^T(\xi)\theta + \dot{y}^*] \quad (12)$$

The law for control of a stable linear dynamic closed-loop system provides as follows:

$$(\dot{y}^* - \dot{y}) + \Lambda(y^* - y) = 0$$

VI: Dynamic model simulations biological wastewater treatment process

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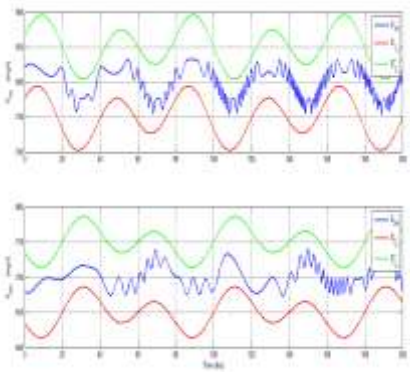

Figure2:disturbance input with s1in and s2in

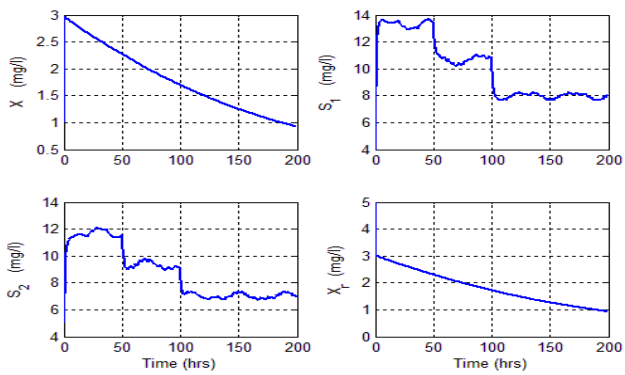

Figure 3:The graph mode variables X, S1, S2 and Xr in closed-loop simulation environment aerobic process to regularize the reference input on the controller maker Linear Feedback

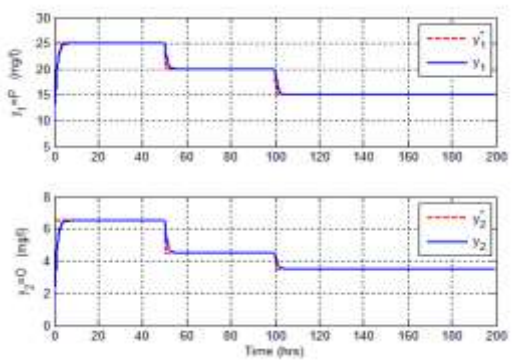

Figure 4:The graph of the output changes y1 = P and y2 = O in closed-loop simulation environment aerobic process for the regulation on the controller reference input linear feedback .

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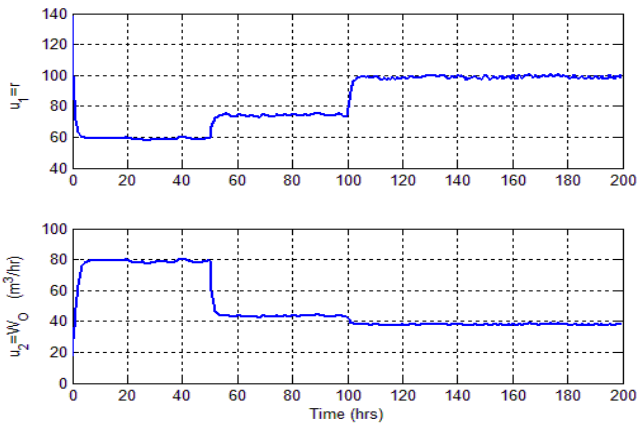

Figure 5: charts input changes u1 = r and u2 = WO closed-loop simulation environment aerobic process to regularize the reference input on the controller maker Linear Feedback

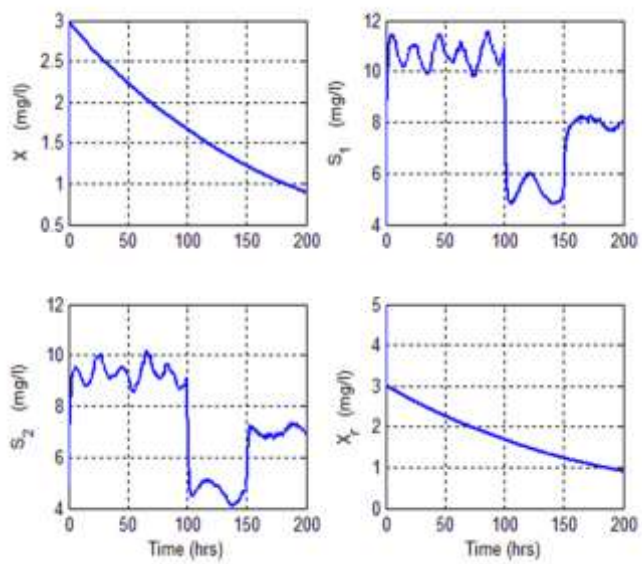

Figure 6: Graph of changes of state variables X, S1, S2 and Xr in closed-loop simulation environment aerobic process to track the input reference line for construction machinery Feedback

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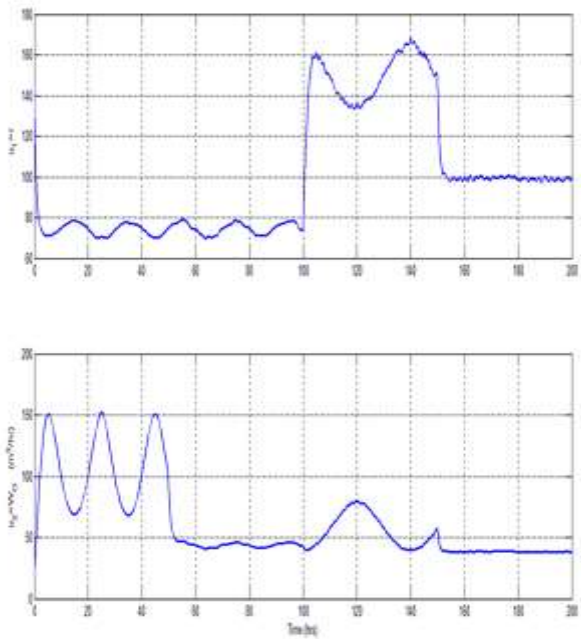

Figure 8: graph input changes u1 = r and u2 = WO closed-loop simulation environment aerobic process to track the input reference line for construction machinery Feedback

Conclusion

In the process of fermentation, aerobic proper aeration is an integral part of achieving a streamlined process and hence controlling the concentration of dissolved oxygen in the aerators is very important in this process. According to the simulation, output is properly converge to reference input. And truly, the concentration of pollutants input and variables flow rate are as uncertainty and confusion on the process of linearization feedback method to control a format suitable, and error control leads to minimum is reached, while the control effort overstep does not cause the phenomenon of saturation in the final element, and not apply to the robustness.

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