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Assoc. Prof. Semenova O.I., Assoc. Prof. Smirnova J.S., student Marchenko A.D, student Zhylyk A.V.
National University of Food Technologies

MATHEMATICAL MODELLING OF BIOLOGICAL WASTEWATER TREATMENT, OF DAIRIES

Rapid development of Ukrainian food industry focuses the increased interest of applied ecology on this sector of the economy. As it is known, dairy industry has a sufficiently large number of unsolved environmental problems, among which the main is the disposal of wastewater. Most dairies'serum with high a COD value is not used in the secondary production and discharged together with wastewater in municipal sewers or natural water bodies, creating significant damage to the environment. One of the effective ways to solve this problem is to increase the efficiency of treatment facilities by constructing mathematical models and further experimental confirmation or refutation of their theoretical results. Biological wastewater treatment is widely used around the world, due to its versatility and relatively low operating costs.

The mathematical description of process regularites of biological wastewater treatment is based on the classical equations of enzymatic kinetics, e.g. the Michaelis-Menten equation, which describes the dependence of enzymatic reaction on the substrate concentration:

$$V = \frac{VS}{K_m + S} \quad (1)$$

where, V = Kkat · E0 - maximum speed of enzymatic reactions; E0 - concentration of biomass of microorganisms, mg/l; Kkat - constant of decay rate of fermentation substrate complex; Km - Michaelis-Menten constant, numerically equal to the substrate concentration at which the reaction rate is equal to V/2; S - substrate concentration, mg/l.

The method of biological wastewater treatment is based on biotic circulation of substances, including recycling processes, transformation and mineralization of organic matter through fermentation process of organic matter by specific set of organisms - aerobic and/or anaerobic active sludge.

The rate of growth of microorganisms is determined by the concentration of limiting substrate and described by Monod, similar to Michaelis-Menten equation, which assumes that the mathematical pattern of a complex population of active sludge growth is similar to patterns of pure bacteria cultures growth, and the principles of enzymatic kinetics can be applied to the "pollution of wastewater - active sludge".

$$\mu = \frac{\mu_{max} \cdot S}{K_s + S}, hr \quad (2)$$

where, μ - specific rate of microorganisms growth, hours; μ_{max} - maximum growth rate of microorganisms, hours; S - concentration of substrate, mg/l; Ks - saturation constants [1].

Using the Mono model values of the number of kinematic parameters (specific rate of growth of microorganisms, organic decay constant depending on certain conditions of the process of fermentation) have been determined.

In order to design the best systems of biological treatment by anaerobic fermentation and define the apparent organic pollution load, duration of treatment and predicting the degree of wastewater treatment and biogas output the kinetic model of fermentation process based on the Mono model has been suggested:

$$\tau = \frac{\frac{1}{\mu_{max} + K}}{\mu_{max}} \cdot \left(\frac{S_0 - S}{S}\right), days \quad (3)$$

where, τ - duration of treatment, days; μmax - the maximum growth rate of microorganisms, hours; K - kinetic parameter of the process; S0 - initial concentration of substrate, mg/l; S - substrate concentration in treated water, mg/dm^3.

As an indicator of substrate concentration the content of organic contaminants is considered as COD, mgO_2/dm^3.

Under the known parameter values and initial concentration of pollution by COD the COD value in treated wastewater can be determined by the following formula:

$$S = \frac{S_0 \cdot K}{\mu_{max} \cdot \tau - 1 + K}, \frac{mg}{dm^3} \quad (4)$$

where, S - substrate concentration in treated water, mg/dm^3; S0 - initial concentration of substrate, mg/l; K - kinetic parameter of the process; S_0 - initial concentration of substrate, mg/l; τ - duration of treatment, days; μ_{max} - the maximum growth rate of microorganisms, hours. It has been determined that the kinetic parameter (K) decreases, and the maximum rate of growth of microorganisms increases with the increasing temperature process.

For example, an increase in temperature from 10 C to 35 C leads to a reduction of K from 7.59 to 2.56, and an increase from 9.90 to 40.82 days. Increasing the setting causes the reduction of a purity degree, thus to deterioration of the process and the impact of metabolic products on the enzymatic process. Temperature effect on process setting is described by Arrennusa principle.

The maximum rate of the growth of microorganisms is described by a linear function in temperature ranging from 20 to 35 C.

The specific biogas yield per unit of the bioreactor volume is described by the modification of the equations of Mono's model:

$$V = \frac{B_0 \cdot S}{\tau} \cdot \left(1 - \frac{K}{\mu_{max} \cdot \tau - 1 + K}\right), \frac{m^3}{m^3} \cdot days \qquad (5)$$

where, B_0 - the maximum biogas yield per unit of organic matter during the continuous processing time, m^3/kg; S - substrate concentration in treated water, mg/dm^3; τ - duration of treatment, days; K - kinetic parameter of the process; μ_{max} - the maximum growth rate of microorganisms, hr [2].

Conclusions: Identification of process parameter K and μ_{max} by the experimental way enables to determine the concentration of pollutants in treated wastewater of dairies and the specific biogas yield by formulas (4) and (5) under different temperatures and initial values of COD, depending on the duration of treatment in bioreactors.

References:

1. Савченко А.І., Дяченко Н.М., Кравченко О.Ю., Математичне моделювання процесу біологічного очищення стічних вод у коридорах аеротенках // Вісник Кременчуцького національного університету імені Михайла Остроградського. – 2012 – №6 (77). – С.109-111.
2. Никитин Г.А. Метановое бродение в биотехнологии. – М.: Стройиздат, 1990. – 207 с.

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