6

BIOLOGICAL (TROPHIC) APPROACH TO WASTEWATER TREATMENT TECHNOLOGY

Yury Reshetilov
Sergei Volodin

Private ecological enterprise "Resetilovs un Coë"
Latvia

In this research I try to determine main principles of biocenosis variation for advanced municipal wastewater treatment. Pure hydrobiological approach has been used.

Besides excessive sludge utilisation - is one of difficult problems in aerobic wastewater treatment. Discussed complicated trophic structure (or several trophic levels) of biocenosis allow to assimilate biomass of bacteria with high rate. Rich and variable biocenosis with complicated trophic structure - is the key to advanced wastewater treatment and perfect excessive sludge utilisation.

Trophic relations are main part of ecosystem (biocenosis) relations. We must well know trophic relations for wastewater treatment process understanding. Therefore, the hydrobionts trophic relations determine a quantity and a quality of activated sludge.

Main nutrition types and trophic relations of activated sludge are shown in Figure 1.

https://doi.org/10.15626/Eco-Tech.1997.006

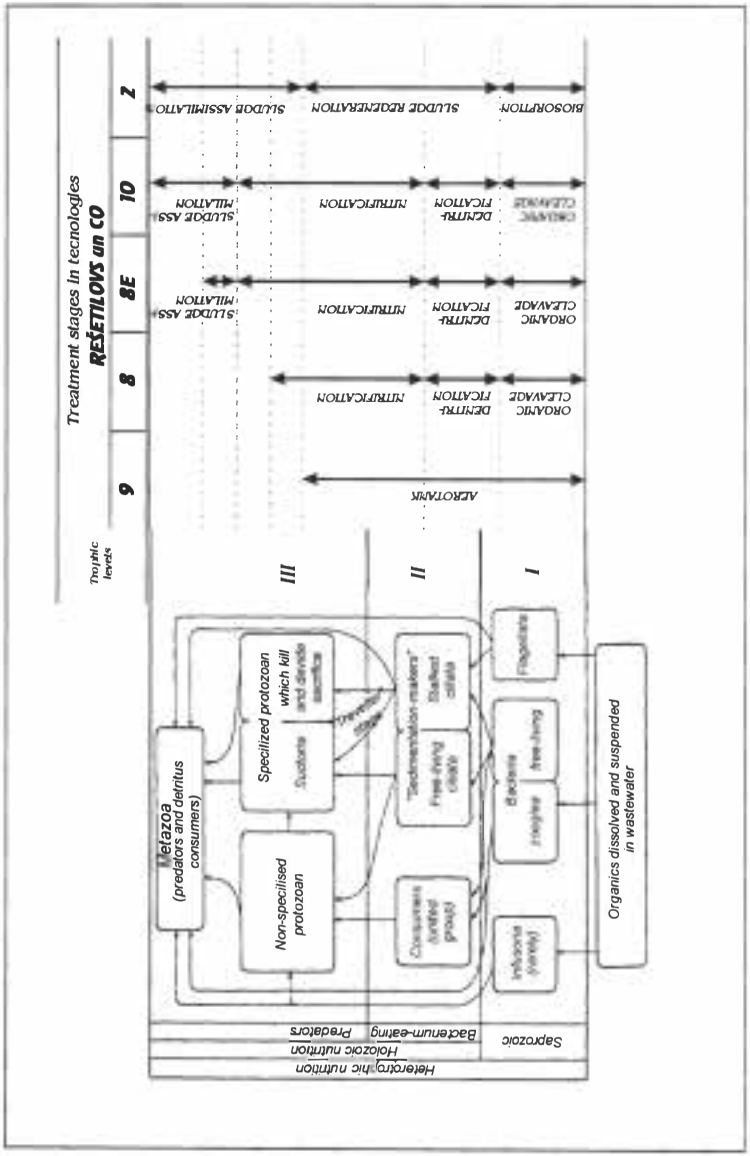

Fig. 1: Trophic relations at activated sludge and "Resetilovs un Co" technologies

In the first treatment stage (or first trophic level) the treatment begin bacteria, some of Flagellate and Infusoria with saprozoic nutrition type (it's nutritions through cell membrane). Mostly pollution removed by bacteria due to they large cells surface, high enzymatic activity and reproduction rate.

Second and third trophic levels characterised by holozoic nutrition type (organism utilise solids - another organisms or large organic particles [patikls]). Quantity of organisms with such nutrition type is limited nor dissolved organic but solids presence. These microorganisms are divided to bacteria-eating and predator. Mostly important bacteria-eating group - "sedimentation-makers" (genera [dzenere] Paramecium, Colpidium, Glaucoma, Tetrachymena, Stentor and others ciliates), which extract special biological lime for large particles of food production. One part of these particles is consumed by ciliates but another increases sedimentation of bacterial mass in clarifier and help treated water clarification.

Highest trophic level - predators and some of bacteria-eating microorganisms. Such nutrition type is usual for predator Rotifera, Nematoda, Oligochaeta, other protozoans and metazoans. These organisms can eat practically all organisms from lower trophical levels

The quantity and biomass of activated sludge organisms, as it usually appear in food pyramids, from level to level decreases several times (up to 10 times).

Also there are shown in this figure relationships of trophic structure and enterprise technologies development.

As you can see in the scheme even enterprise's simplest technology (9 type) utilises all trophic levels, but more advanced technologies provide a conditions for development in large quantities worms, rotifers, ciliates and other predators for bacterial biomass removal in last stage of treatment process.

And some words about Trophic theory and technology.

As has been shown earlier by different researchers - the bacterial mass varies during treatment in high degree. From our point of view, researchers didn't explain real reason of such variation. They not mention protozoan and metazoan influence.

Common aerotank designed for full oxidation have low excessive sludge production but it characterised by first trophic level and beginning of second level presence due to strong sludge circulation, loading variation and poor oxygen supply (Fig. 2).

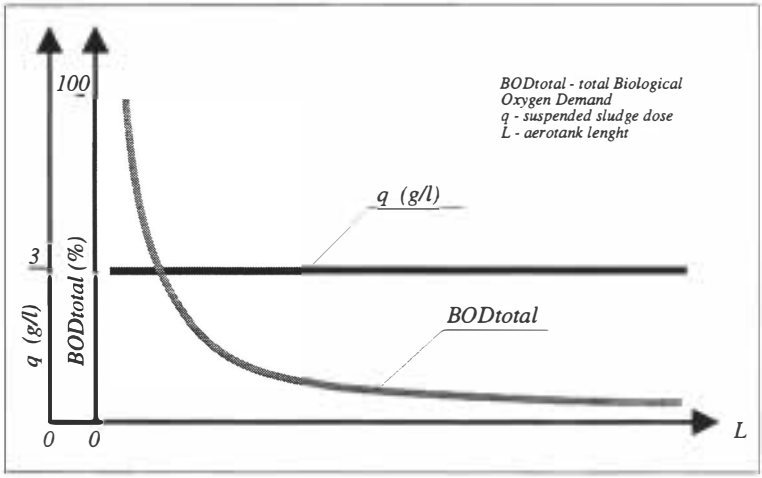

Fig. 2: BOD removal - suspended sludge dose relationship in traditional aerotank

As you can see - traditional aerotank is characterised by permanent suspended sludge dose during BOD decreasing along it's length.

Ideal aerotank with beautiful trophic structure is aerotank with fixed-film media without suspended sludge and recirculation (Fig. 3).

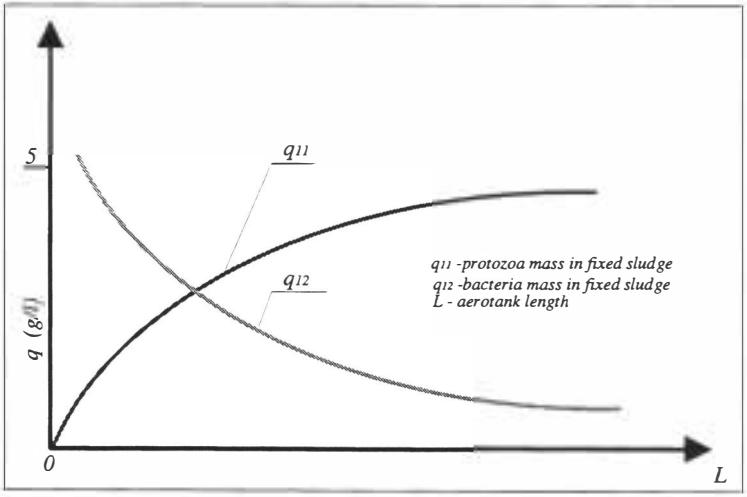

Fig. 3: BOD removal - protozoan and bacterium doses realtionship in aerotank with fixed film media

It is shown that protozoan dose increase but bacteria dose decrease along aerotank length. The protozoan beautifully remove biomass of bacteria on fixed media.

But such technology has main fault - during treatment not removed nutrients nitrogen and phosphorus). This problem can be decided by using of suspended and immobilised (or fixed) sludge simultaneously. Such principle used in all our enterprise technologies (we have about ten Latvian Republic patents). A data of other researchers and our long-term study show, that biofilm contains 2-3 times more protozoan and metazoan than suspended sludge. Fixed sludge has very complicated trophic structure. Relations among doses of bacteria in suspended sludge and fixed sludge and protozoan in fixed sludge are shown on Fig. 4.

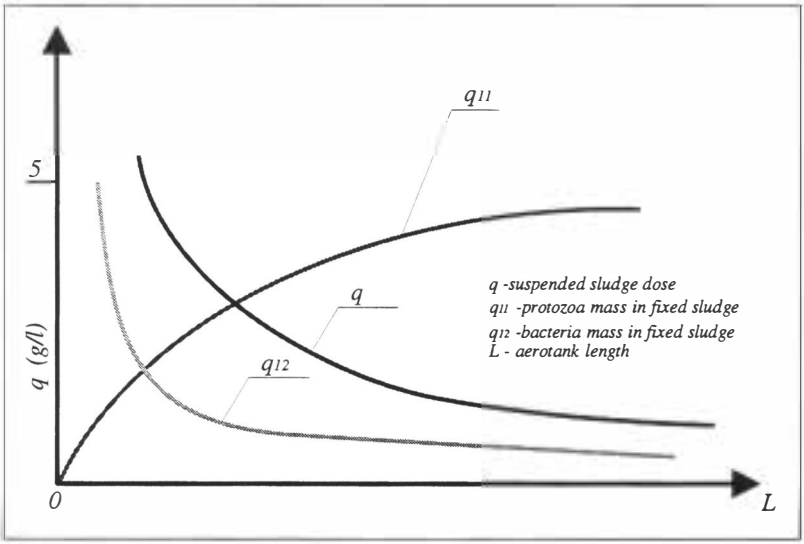

Fig. 4: BOD removal - doses of bacterium in suspended/fixed sludge and protozoan relationship in "Resetilovs un Cœ' reservoirs

Bacterium mass decrease in fixed and suspended sludge but protozoan mass in fixed sludge increase. There are closest relationships among BOD removal and biomass changes in such case (Fig. 5).

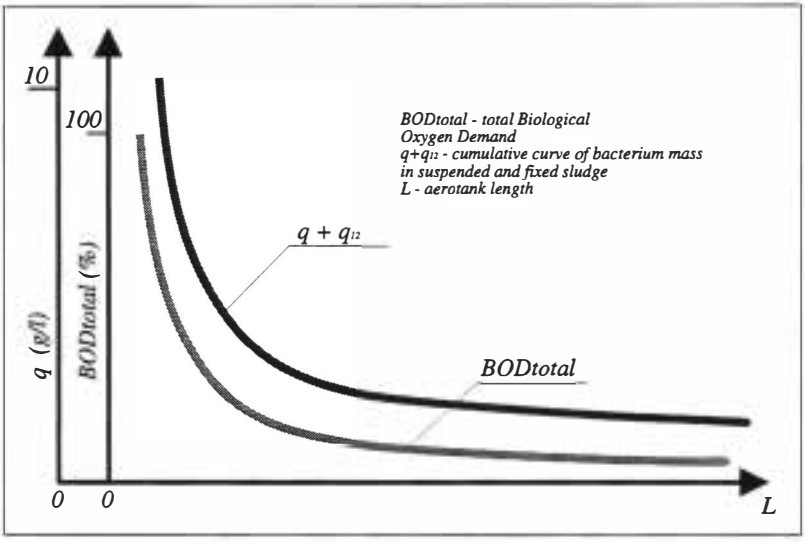

Fig.5: Relationship BODremoval and biomass change

This circumstance is perfect for wastewater treatment. It is known that excessive sludge utilisation takes up to 50% wastewater treatment plant price. Our technologies allow remove bacterium mass (excessive sludge). Biological sludge assimilation decides problem with sludge utilisation.

FINALLY CONCLUSIONS

1. First of all, the technologies with complicated trophical structure allow to optimise biological sludge utilisation.
2. Secondly, the biological sludge utilisation:
   - minimise capital cost and energy consumption;
   - allow to simplify WWTP maintenance.