faculty of
food technology
and biotechnology
University of Zagreb

međunarodni znanstveno-stručni skup
19. Ružičkini dani
DANAS ZNANOST – SUTRA INDUSTRIJA
21. – 23. rujna 2022. | Vukovar, Hrvatska

Municipal wastewater treatment by aerobic granules

Dijana Grgas[1], Marija Biškup[1], Mirjana Galant[2], Tea Štefanac[1], Tibela Landeka Dragičević*[1]

[1]University of Zagreb, Faculty of Food Technology and Biotechnology, Pierotti Str. 6, 10000 Zagreb/Croatia
[2]Odvodnja Poreč d.o.o., Mlinska ulica 1, 52440 Poreč/Croatia
*Corresponding author

Introduction

Aerobic granular sludge (AGS) is spontaneously formed compact microbial biomass by self-imobilisation of microbial communities in the matrix of extracellular polymeric substances (EPS). AGS, in comparison to activated sludge process, has some advantages such as rapid settlement and simple separation of treated water from microbial biomass, higher wastewater treatment efficiency, lower surplus sludge production, lower footprint, higher biomass concentration in the bioreactor and decrease of the size of the wastewater treatment plant. AGS contains millions of microorganisms per gram of biomass. Due to the dense and layer structure of granules, the gradient of substrate and oxygen is formed from the outer surface of the granule towards the granule core, which enables the existence of different microbial species with different metabolic features.

The municipal wastewater is characterized by low chemical oxygen demand/nitrogen (COD/N) ratio and therefore, for the efficient wastewater treatment, the addition of carbon source is usually required.

Materials and methods

- SBR-2 cycles per day: 20 min reactor feeding, 11 h and 10 min reaction phase – aerobic conditions, 10 min settling, 20 min decanting
- SBR reactor - 2 L working volume, C-source (sodium acetate), C/N ratio 4
- Synthetic wastewater which imitated the municipal wastewater – the NH_4-N concentration 70±10 mg NH_4-N/L
- Activated sludge granulated with the reduction of settling time – the gradual decrease from 30 min to 10 min settling time; for the experiments the mature granules were used
- MLSS (mixed liquor suspended solids), COD, TN (total nitrogen), NH_4-N, NO_3-N, NO_2-N and PO_4-P determined according to Standard methods (2005)
- Temperature, dissolved oxygen (DO) concentration and pH value – WTW Dur Ox and WTW 3210 Oxi, and WTW SenTix 41 and WTW 330i
- Dissolved oxygen (DO) concentration during the react phase – 2 mg/L, temperature 22±2 ^{o}C and pH value 7-8

Discussion

- The ratio C/N 4 resulted in 90 % COD removal, 91 % NH_4-N removal, 55 % TN removal, and 31 % PO_4-P removal (Fig. 1)
- The MLSS concentration was more-less constant, with minor fluctuations (Fig. 2)
- For the organics removal were responsible the heterotrophic species
- The NH_4-N was removed during the nitrification (aerobic, autotrophic) process in which the nitrifying bacteria oxidize NH_4-N to NO_2-N and then NO_2-N to NO_3-N
- The NO_3-N is removed in denitrification process (anoxic, heterotrophic) in which the NO_3-N are reduced to N_2 with electron donors provided from acetate
- The PO_4-P removal was performed by the phosphorus accumulating organisms (PAO) - required anaerobic (P release and C uptake) and aerobic phase (P uptake)
- The competition for oxygen between aerobic heterotrophs and nitrifiers occurred. Also, the organics consumed aerobic heterotrophs, denitrifiers and PAO
- The ratio C/N 4 was not sufficient for complete denitrification of nitrates, and for complete phosphorus removal
- The simultaneous removal of COD, TN and PO_4-P was achieved due to the layered structure of aerobic granules which enabled the co-existense of aerobic, anoxic and anaerobic microbial species along the granule diameter

Results

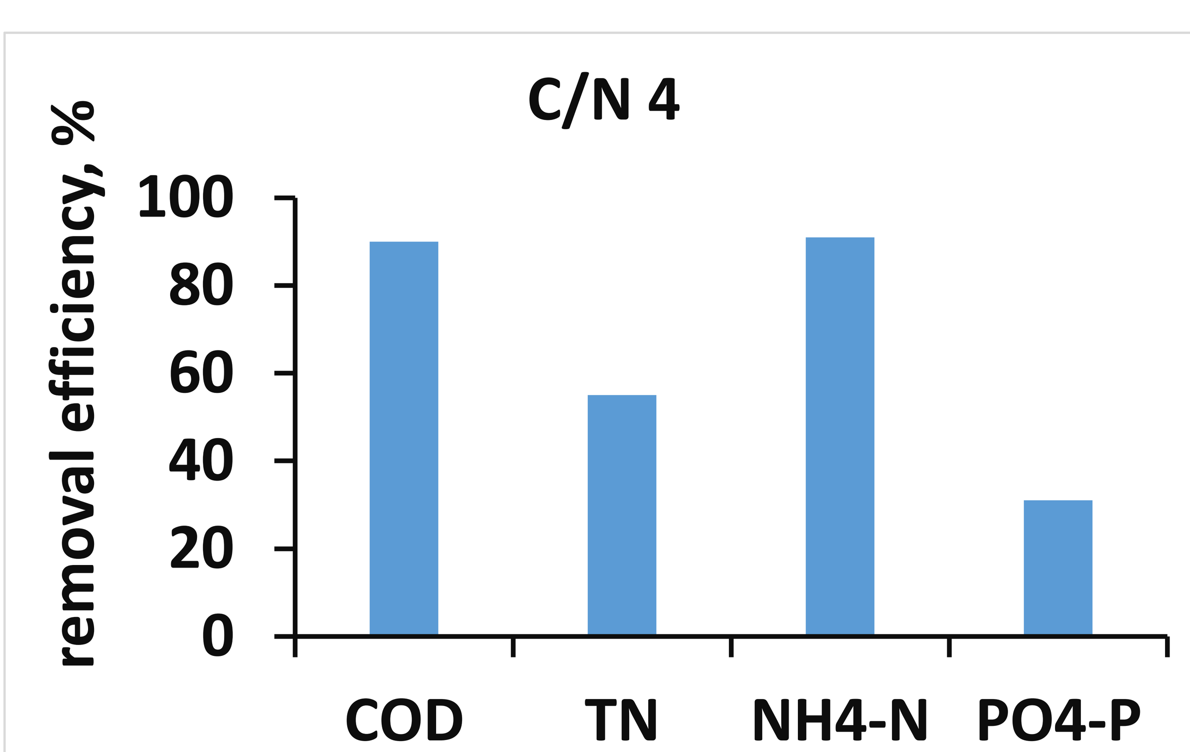

Figure 1. Removal efficiency of COD, TN, NH_4-N and PO_4-P

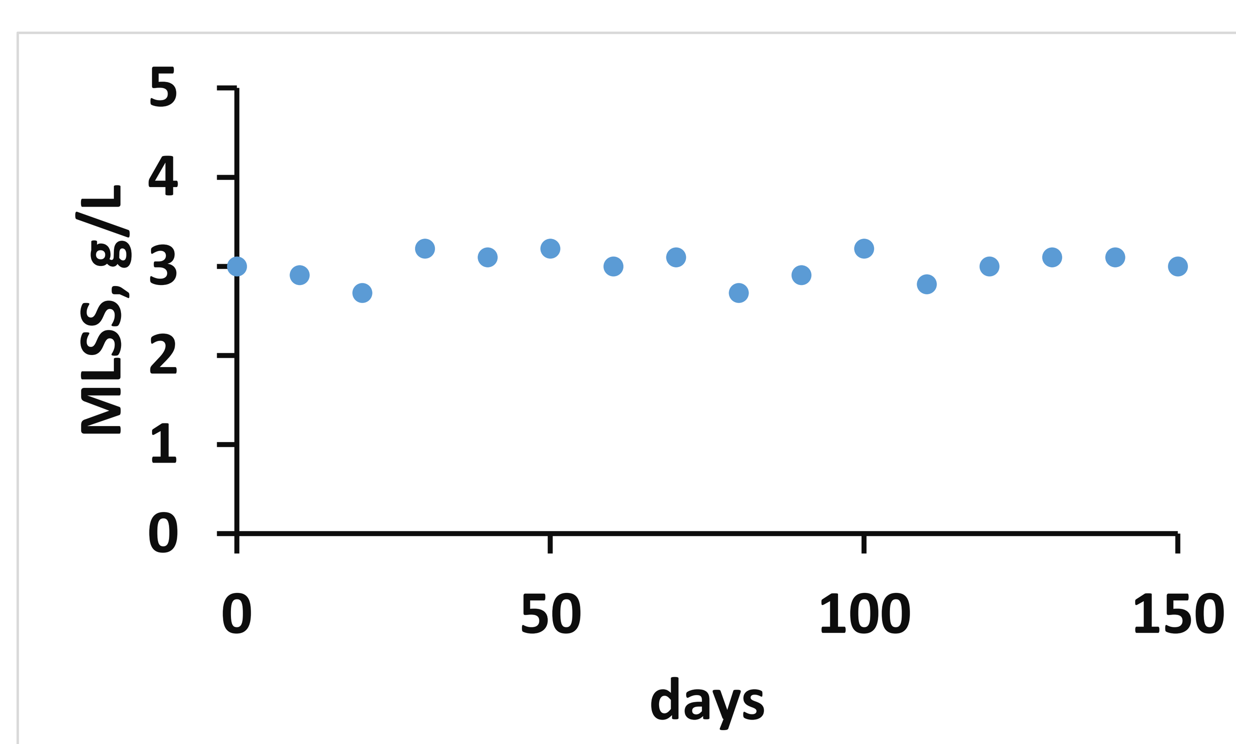

Figure 2. The MLSS variations during 150 days

References

APHA (2005) Standard Methods for the Examination of Water and Wastewater. APHA.

Adler A, Holliger C (2020) Multistability and reversibility of aerobic granular sludge microbial communities upon changes from simple to complex synthetic wastewater and Back. Front Microbiol 11, 574361.

Desireddy S, Sabumon PC (2021) Development of aerobic granulation system for simultaneous removal of C, N, and P in sequencing batch airlift reactor. J Environ Chem Eng 9, 106100.

Hamza R, Rabii A, Ezzahraoui FZ, Morgan G, Iorhemen OT (2021) A review of the state of development of aerobic granular sludge technology over the last 20 years: Full-scale applications and resource recovery. Case Stud Chem Environ Eng 100173.