УНИВЕРСИТЕТ ИТМО

MODELING THE PROCESS OF BIOLOGICAL TREATMENT OF AIR CONTAINING MALODOROUS SUBSTANCES UNDER LABORATORY CONDITIONS

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THE AIM OF THE STUDY

Development of a laboratory unit to simulate the process of air purification from malodorous substances

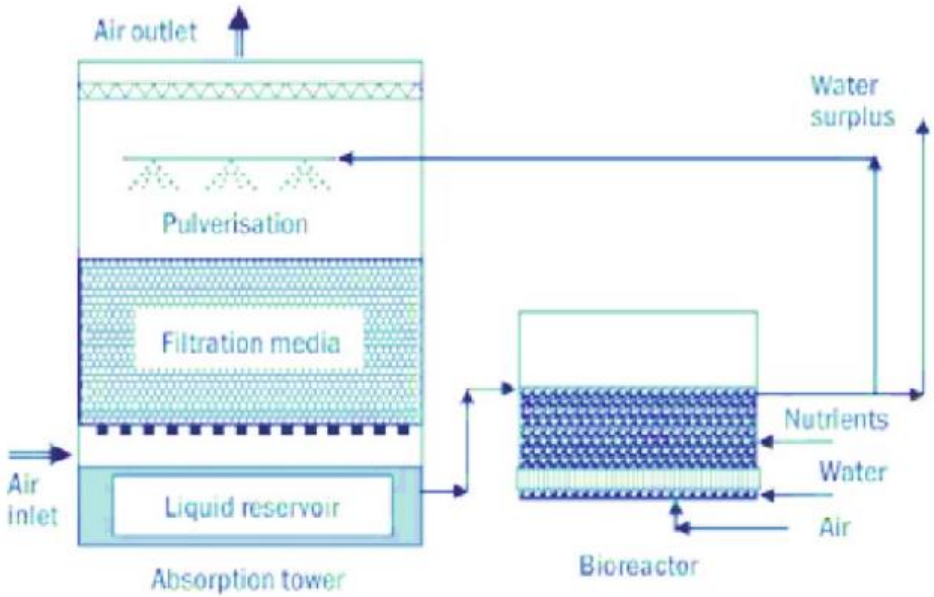


Figure 1 Schematic representation of Bioscrubber (http://cdn.intechopen.com/pdfs-wm/45120.pdf)

RESEARCH OBJECTIVES

identify the possibility of applying the biological treatment method based on the quantitative and qualitative composition of the emissions of the poultry farm

assemble the laboratory installation and to select optimal parameters of its operation

create optimal conditions for the existence of microbial community of destructors

Analyse the results obtained

RELEVANCE

- Emissions from poultry houses consist mostly of volatile compounds, which have an unpleasant odour and are easily bio-oxidised. Taken together, these compounds constitute a specific odour that, depending on the season and weather conditions, **travels considerable distances: up to 0.5 km in winter and up to 3.5-5 km in summer.**
- The biological method was chosen as the most efficient treatment method, with low temperatures and low costs

Figure 2 Poultry housing conditions

THE MAIN MALODOROUS POLLUTANTS OF THE POULTRY FARM AIR

Name of airborne odorant	Concentration of the substance in the air (mg/m3)	How many times the concentration exceeds the perception threshold
CH_3SCH_3	0,21	568
H2S	4,52	151
CH_3SH	0,0004	13
CH_3NH_2	0,04	0,08
NH_3	2,36	4
The particulates	1,14	-

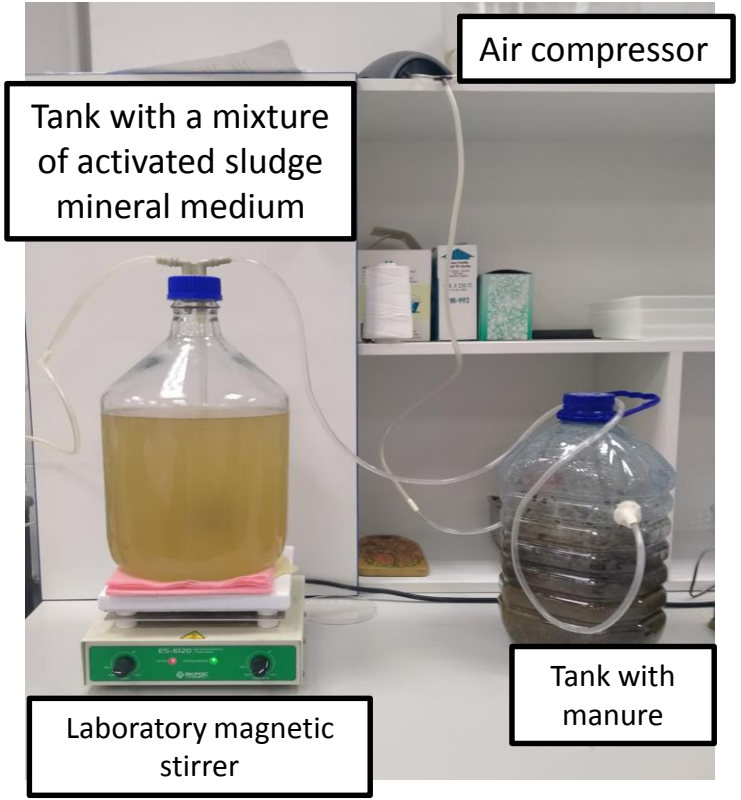
APPLICATION I

Unit was operated in December 2020

1. Continuous aeration - air volume 5 L/min.
2. Continuous mixing
3. Operating volume of activated sludge and nutrient media mixture - 5 litres
4. Mineral media composition:

K_2HRO_4 - 2 g/l;
KH_2PO_4 - 2 g/l;
$FeSO_4*7H_2O$ - 0.2 g/l;
$CaCl_2*2H_2O$ - 0.05 g/l

5. Monitored parameters: pH, optical density, ammonia ions concentration



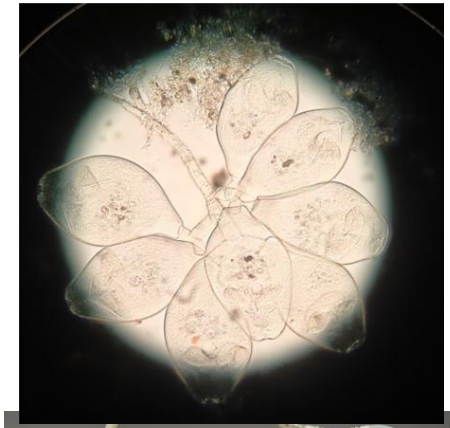
APPLICATION II

The composition of the mineral environment has been changed:

K_2HPO_4 – 2 g/L;
KH_2PO_4 - 2 g/L;
$MgCl_2*6H_2O$ – 0,4 g/L;
$CaCl_2*2H_2O$ – 0,05 g/L

The source of the activated sludge and its concentration (1:4) in the reactor tank has been changed

Monitored parameters: pH, nitrate ions concentration



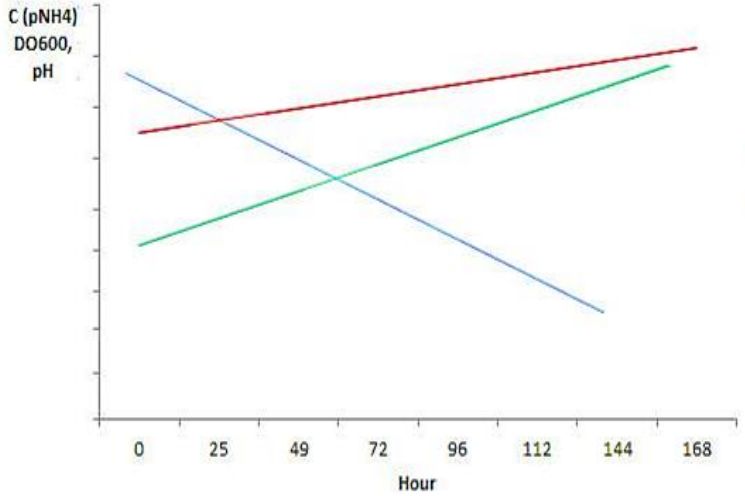
Unit has been operating since 1st of April of 2021

METAGENOMIC ANALYSIS OF MICROBIAL COMMUNITY APPLICATION I

Name of the species	Active sludge before treatment (%)	Active sludge after treatment (%)
Candidatus Nitrocosmicus	4,4	4,3
Nitrosomonas spp.	0,2	0
Nitrobacter spp.	-	-
Arthrobacter spp.	-	-
Pseudomonas spp.	-	-
Alcaligenes spp.	-	-
Nitrosospira spp.	-	-

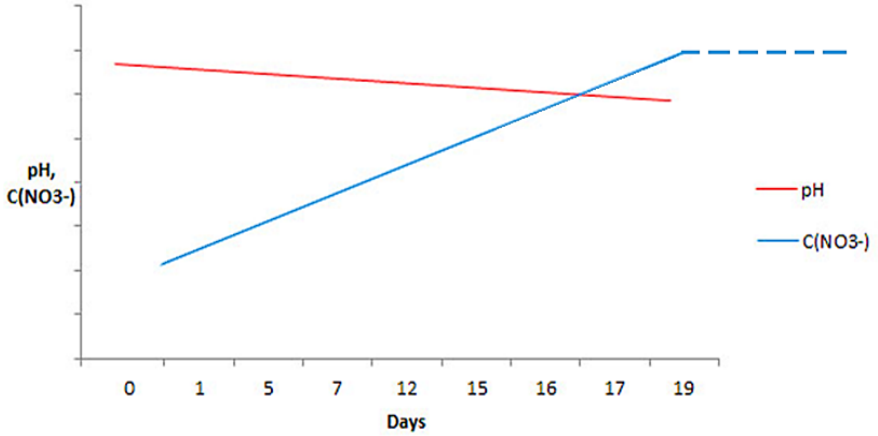
Taxonomic analysis of the bacterial community was performed by identifying the variable region of the 16SpPHKv3-v4 gene (Illumina technology), specific for a wide range of microorganisms, including bacteria and archaea.

RESULTS



Application I

A drop in optical density was observed, giving an indirect indication that microbial growth was not taking place, while pH increased gradually throughout the experiment, as did the content of ammonium ions



Application II

The pH value is stable, indicating favourable conditions for nitrification processes, while the content of ammonia degradation intermediates (nitrate ions) is steadily increasing

CONCLUSION

- A laboratory apparatus for biological air treatment has been set up
- There were selected the operating parameters
- There has been obtained a poultry farm air analysis
- Microbial metagenomic analysis was performed

Further it is planned to continue experiment 2 with maintenance of operating parameters and conditions until achievement of leveling of nitrate-ions concentration and calculation and design of laboratory bioscrubber

Thank you for your attention!

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