

Hydraulic simulation of fecal sludge dehydration, based on case studies in Portugal and Mozambique

Summary

The use of sludge drying beds and the mathematical modeling of their performance is of particular importance for the management of faecal sludge in developing countries such as Mozambique, as it is believed that this low-cost sanitation technology will most likely be applied to a significant part of the small towns and cities, as an important component of safe sanitation.

The focus of this work was to carry out an in-depth study of the process of faecal sludge dewatering in drying beds, focusing mainly on the analysis of the hydraulic performance (through the evolution of moisture content), as well as on the development of an integrated mathematical model that fundamentally describes the water balance of the dewatering process. Additionally, tests were carried out to assess the evolution of the concentration of E.coli in the sludge, through time.

The study involved experimental campaigns at two pilot plants, namely in the city of Tete, Mozambique, and at the Póvoa da Galega wastewater treatment plant in the Lisbon region, in Portugal. The campaigns were aimed at determining components of the hydraulic balance and the E. coli bacteria content, as well as obtaining experimental data for calibration and validation of the model. In the case of the city of Tete, the sludge source were septic tanks and latrines. In the case of Povoá da Galega, the sludge came from the anaerobic digester of the wastewater treatment plant.

The mathematical model developed aims to predict, mainly, the retention times necessary for the dewatering of faecal sludge, in order to reach a certain solid content, or percentage of dry matter, based on the application of equations that describe the water balances for different operational conditions. The model is essentially based on the estimation of two components: gravitational drainage of free water and evaporation of adsorbed water.

According to the results, a large amount of the water present in the sludge was removed essentially by gravitic drainage, about 90% in the case of Póvoa da Galega, Portugal, and about 80% in the case of Tete, Mozambique. In Tete, after 15 days of faecal sludge dewatering, the final moisture content ranged from 28 to 88%. For the same period, in the tests of Póvoa da Galega, Portugal, the moisture content varied between 85 and 90%.

Within the scope of the dewatering of sludge in drying beds, a significant reduction of E.coli bacteria took place in both pilot plants, with a reduction of 0.5 to 2 Log, in about 13 days. The developed model was applied to different climatic conditions, with, in general, satisfactory results.

Keywords

Drying beds, evaporation, faecal sludge, gravity drainage, integrated modelling, Mozambique.



Pilot plant in the city of Tete (left); weather station (center); loading the beds (right).



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Period

2015-2020

Funding

Camões, Instituto da Língua e Cooperação (CICL) scholarship