

# From Waste to Resource: Eco-Toilet as a Novel Resource Oriented Sanitation Practice

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## Abstract

Because of lack of access to suitable sanitation practices and demand of sustainable practices, achieving Sustainable Development Goals (SDG) 6 is becoming one of the priorities for developing countries. Ideally sustainable resource oriented sanitation should be waterless, waste source separated and having ability to utilize wastes as fertilizer. In this paper, a new sanitation system called Eco-Toilet is being introduced. This system uses no water, separates urine from faeces and has onsite treatment system in order to turn the collected wastes into fertilizer. The bio-reactors can improve the fertilizing characteristics of urine as well as digesting the collected faeces with the least possible energy consumption. This system can be applied in developing countries as a waste to resource oriented sanitation system on the way of achieving SDG 6.

## Keywords

Eco-Toilet; Resource Oriented Sanitation; Sustainability; Waste onsite Treatment; Waterless Sanitation System

## INTRODUCTION

One in ten of world's population do not have access to adequate sanitation and safe drinking water. Absence of improved water supply alone poses risk of diarrhoeal disease by 6.9 times and absence of sanitation poses risk of 8.7 times. Absence of both poses risk of 11 times. (WHO/UNICEF 2013). In this case for improving the sanitation condition of the world Sustainable Development Goals (SDG) 6 has been defined. The main purpose is making access to safe sanitation practice anytime anywhere. On the way to achieving SDG 6, first the characteristics of an ideally sustainable sanitation practice should be defined. These characteristics can be listed as being waterless, being able to separate urine from faeces and being able to utilize waste as fertilizer. In this paper, based on these principles, a novel sanitation system called eco-toilet is introduced and the function of the storage waste bio-reactors and their abilities on turning urine into fertilizer and digesting collected faeces were studied.

## ECO-TOILET SANITATION SYSTEM

Figure 2 presents a schematic diagram of this system. It is waterless and separates urine from faeces using a conveyor belt and stores them into separated bio-reactors. The source of bacteria is the *Nitrosomonas Europaea* with concentration of  $6 \times 10^6$  cells in 100 ml. The roles of these bio-reactors are different. The bio-reactor of urine is for onsite treating urine into a suitable fertilizer while the faeces reactor mixes faeces with mentioned bio-seed and solid additives like rice husk by a mixer in order to digest and reduce the weight of faeces. This mixing process and the conveyor

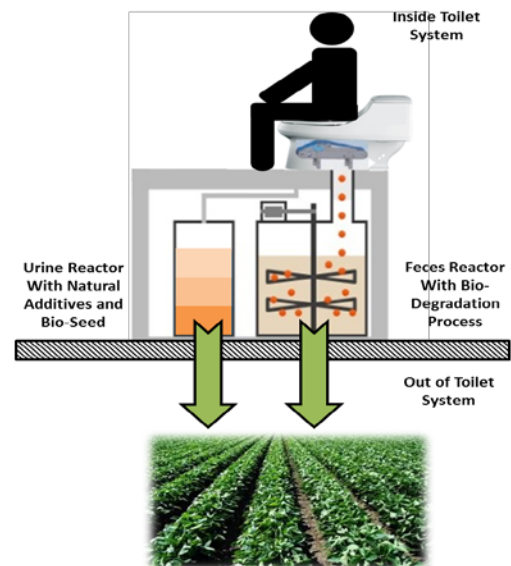
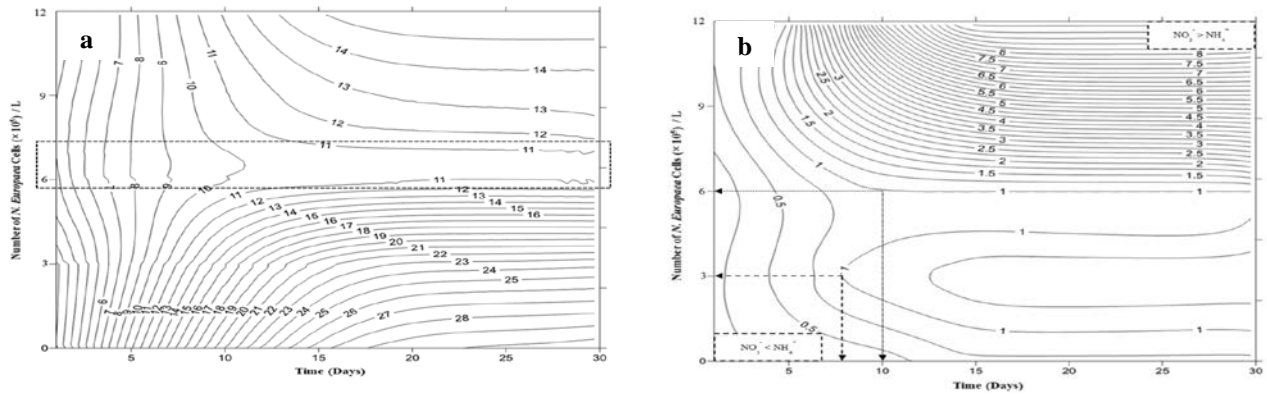


Figure 1. Schematic View of Eco-Toilet Sanitation System



**Figure 2.** (a) Percentage of Nitrogen Loss at Different *N. europaea* Bio-seed Concentrations and Durations; (b) Nitrate : Ammonium ratio at Different *N. europaea* Bio-seed Concentrations and Durations

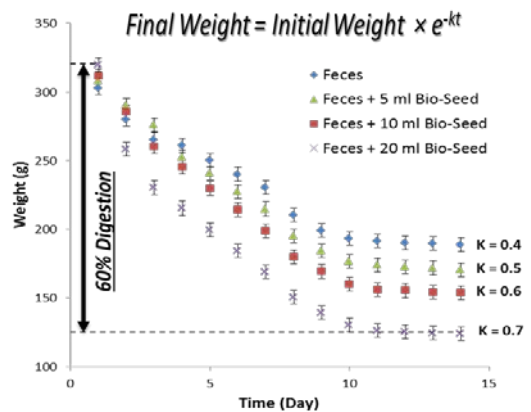
belt movement are the only functions that require energy which can be provided using solar cells. After digestion the content of this bio-reactor can also be used as a fertilizer.

### FUNCTION OF URINE AND FAECES BIO-REACTORS

In urine bioreactor ammonia loss as gas is a critical issue. This is because not only losing ammonia is losing nutrients but also this loss is the main source of urine smell. Hashemi et al. (2016) study shows that adding  $6 \times 10^5$  Nitrosomonas Europaea bio-seed Cells to 1 liter urine can control the ammonia loss and prevent smell as it is presented in figure 2. This study also yields that this dosage of bio-seed can make urine as a liquid fertilizer which has the characteristics of the European Commission standard by modifying the ratio of  $\text{NH}_4^+$  to  $\text{NO}_3^-$  as 1:1. This means that not only the nutrient loss reduces but also this onsite treatment can produce a ready-to-use fertilizer from Urine. In faeces bio-reactor, a mixture of bio-seed with solid additives is being used to reduce the amount of collected faeces by bacterial digestion. Figure 3 yields that for 300 gr faeces, adding 20 ml of the mentioned bio-seed can digest the collected faeces up to 60%.

### CONCLUSION

In this paper, Eco-Toilet is being introduced as a novel sanitation practice on the way to achieving SDG-6. This toilet is waterless, Separates urine from feces and is supposed to utilize waste as fertilizer. The function of storing tanks as bio reactor shows that not only ammonia loss and the smell of urine can be controlled but also urine can be changed into a standard fertilizer by being treated onsite. The feces bio-reactor can also digest it up to 60%. All these benefits with the lowest possible energy consumption can make this toilet as a sustainable solution for many sanitation problems.



**Figure 3.** Digestion Process of Faeces in Eco-Toilet

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