NEWLY DEVELOPED MEDIUM-TECH DECENTRALISED SANITATION CONCEPTS FOR CLOSING NUTRIENT AND WATER CYCLE

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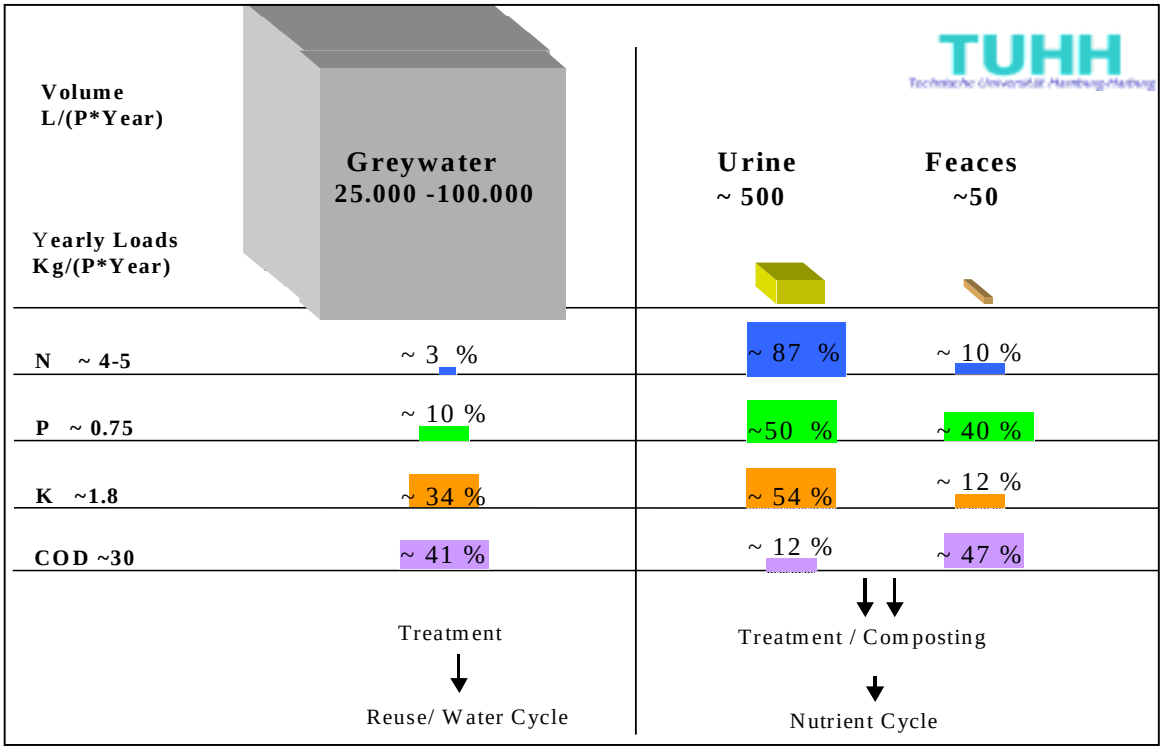
The term “Medium – Tech” refers to a sanitation system which is still not a low-Tech, but also not a High-Tech.

The development of alternatives sanitation concept is becoming more and more indispensable for both economic and ecological reasons, since the design of conventional sanitation concept was based on the wrong assumptions that resources are unlimited and the waste produced from the resources at household is only suitable for disposal in the environment where it could be assimilated by the nature. These assumptions fail to complete the resources loop. Therefore, we must take sever consequences e.g. pollution of aquatic environment, water scarcity, causing depletion of fossil resources, degradation of agricultural land, intensive energy use, high cost and spread of water-borne disease . Unfortunately, Agenda 21 failed to promote waste reuse and recycling methods related to sanitation, although water and fertile land are core subjects of survival of the future generation (Otterpohl et al., 1999). Moreover, it gave no indication as to the level of technology that would be most appropriate to pursue in the developing countries (Sanchez, 1993).

“ Don’t mix – faeces, urine, water “ concept of Uno Winblad (1997) has given a new paradigm in sanitation. Source control sanitation can solve many problems (Otterpohl et al. 1999). Design of source control sanitation aims for a high hygienic standard and full reuse of resources. For this cleaver source control is required (Otterpohl, et al., 2000). A vision of separating household wastewater into three streams bases on the fact of very different characteristics of grey water, yellow water (Urine with or without flush water) and brown water (toilet water without urine) (table 1). The typical characteristics of the streams of household wastewater clearly reveal that urine contributes about 87% of nitrogen, 50% of phosphor and 54% potassium to the domestic wastewater, whereas grey water, despite very large volume compared to urine, contributes only about 3% of nitrogen, 10% of phosphor and 34% potassium. Therefore, domestic waste water without urine avoids the costly nitrification- denitrification process. Furthermore, greywater can be treated with simple biological methods and reused for many purposes. Faeces, which is 10 times smaller in volume than urine, contains high organic load and pathogens which kills some millions people annually world wide. Faeces, however, can be sanitised and used as soil conditioner (Esrey et al., 1998), whereas urine can be treated and used as fertiliser (Joensson et al., 1999)

Table 1. Typical Characteristics of the Main Components of Household



Wastewater

On the basis of above mentioned fact new sanitation concept has been developed (Fig.1). Source separation at household bases on separation toilets having two bowls, front one for urine and rear one for faeces (Fig.2). Many applications of the separation toilets can be found in Sweden (Joensson et al., 1999).Yellow water is then collected and storage in tank until it is used for agricultural purposes. The storage period should be at least half a year, since this is an appropriate time for tank emptying and part of the eventual medicament residues can be destroyed during this time period. The brown water can be discharged into the precomposting chamber (Rottebehaelter) having two filter bags hanging side by side in it, where solids of the discharge are retained in the bag whilst the liquid phase or filtrate flows through it (Fig.2). The accumulation of the organic stuff in the bag can lead an aerobic decomposition. After six months of the filling of the first bag (size of the bag is so designed that it is supposed to be filled up in six months) the inflow is diverted into the next bag. The first bag is left inactive for six months to complete precomposting. After that it can be taken out from the chamber and composted with other kitchen wastes. After a long time composting it can be used in the agricultural land. Because of urine separation at source, the filtrate contains very low nutrients. The greywater with or without filtrate can be undoubtedly, after simple biological treatment e.g. constructed wetland, sequencing batch reactor (SBR), slow sand filter, disinfection etc , either reused or discharged into the watercourses or infiltrated into the ground. The Composting Chamber (Rottebehaelter) followed by a constructed wetland has been increasingly used in the rural areas of Germany, Austria and Switzerland.

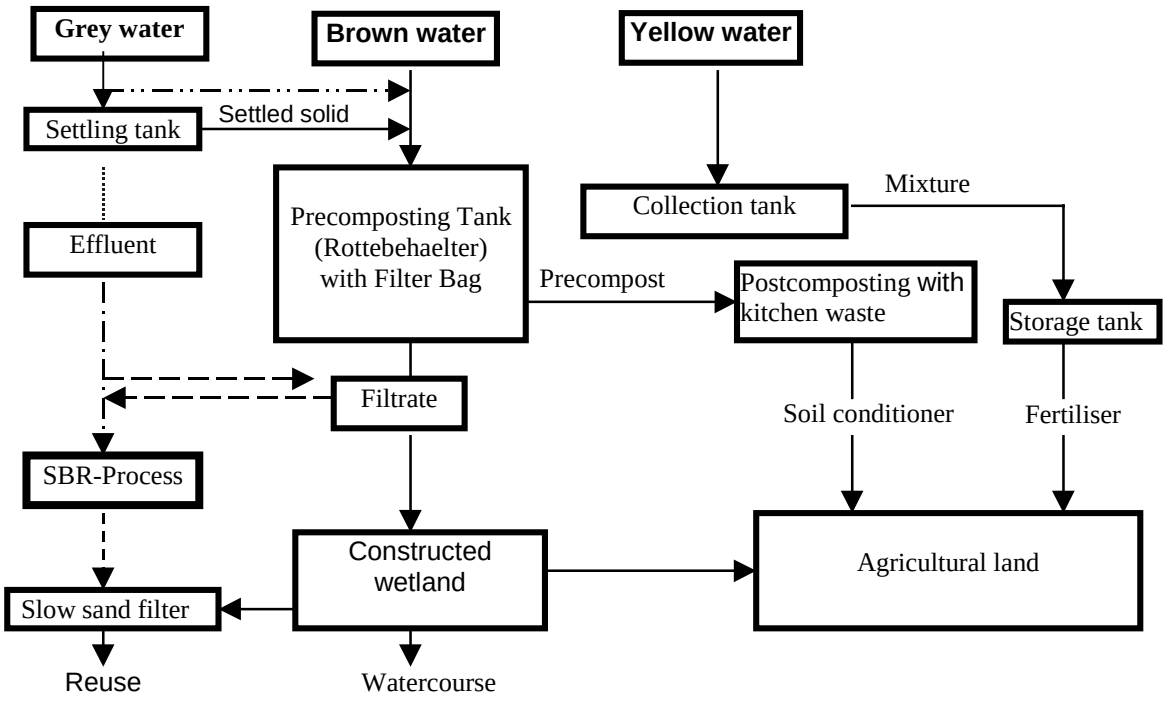


Fig.1. Sanitation Concept for Closing Nutrient and Water Cycle

The new concept (without SBR, Slow sand filter) has been installed at the Lambertsmuele in a rural area in the region of Cologne, Germany. The Lambertsmuele, a historical watermill, has been put under preservation since 1983. At the moment it is reconstructed to a museum. Due to the restoration of the building the wastewater treatment had to be reconstructed as well. Until now all the wastewater has been collected in a collecting tank.

Wastewater of the residents and museum visitors has been separately captured at the source. The source separated flows have been treated separately outside of the building. A newly developed separation toilets where no water is needed to the urine flushing, a mechanical device closes the urine pipe when users stand up and water free urinal have been installed. Urine (yellow water) has been collected and stored in the storage tank until it is used for agricultural purposes. The storage period is at least half a year. For brown water an underground composting chamber (Rottebehealter) has been used. The composting chamber has strong advantages against the methane emitting septic tank which also does not allows reuse of nutrients. The septic tank content has to pump periodically with the help of a vacuum tanker and taken away for treatment. It has high operating costs and demands a high level of municipal organisation. Also access to individual houses and street congestion may create difficulties in areas of high population density.

No treatment plant is needed for further treatment, local post composting of the composting chamber contents that have already been dewatered and pretreated at least for a year can produce materials for soil conditioning. Usage of filter bag makes handling and transporting easy. In this case the greywater has been also pre-treated in the composting chamber. The effluent of the chamber, which has low nutrients loads as urine is captured at the source, has been treated with a vertical constructed wetland

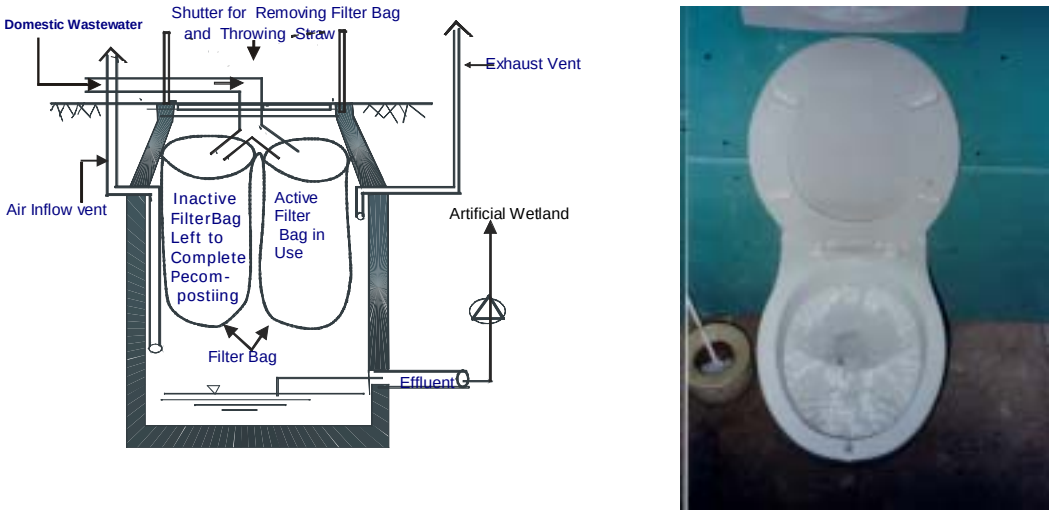


Fig.2 Precomposting Chamber with Filter Bags and No-Mix Toilet

In this concept flushing for urine bowl needs no water at all whereas flushing water for faeces bowl can be adjust at the required amount (maximum 6 litre). However, separate collection is only possible when men sit down while urination. It is still not a low-tech, but can provide a low cost and relatively low maintenance system with a potential of full resources recovery. This medium-tech sanitation system is suitable for rural settlements and less densely populated peri-urban areas. Experience shows that this type of system is usually well accepted. The toilet is still a flush toilet but there is much less water consumption. Maintenance has to be organised in a proper way as in all decentralised systems.

References

Esrey, S.A., Gough, J., Rapaport, D., Sawyer, R., Simpson-Hébert, M., Vargas, J., and Winblad, U. (1998) Ecological sanitation. Swedish International Development Cooperation Agency, Stockholm.

Jönsson, H., Vinnerås, B., Höglund, C., and Stenström, T.-A. (1999) Source separation of urine.
Wasser & Boden **51**(11), 21-25., Blackwell Wissenschafts-Verlag, Berlin, Germany

Otterpohl, R., Oldenburg, M., Zimmermann, J. 1999: Integrated Wastewater Disposal for Rural Settlements. Wasser & Boden, 51/11,1999, pp. 10-13, Blackwell Wissenschafts-Verlag,
Berlin, Germany

Otterpohl, R. 2000: New Developments of EcoSan in Germany and Europe, proceeding of the
International Symposium , EcoSan, GTZ, 30-31 October 2000,Bonn, Germany.

Sanchez, A. (1993) Review: Sustainable Management of Solid Wastes in Southern Mali. Bulletin No.
55 CTA Wagenigan The Niederlands

Winblad, U. (1997) Toward an Ecological Approach to Sanitation. In: Simpson-Herbert M and Wood
S eds., Sanitation Promotion Kit, Geneva, WHO (Unpublished Document WHO/EOS/97.12)

Wolgast, M. (1993), WM-Ekologen ab, PO Box 11162, S-10061 Stockholm, Sweden.