Engineering Approach for Selection and Design of Treatment Technologies

Faecal Sludge Management (FSM) is a relatively new and rapidly growing field. There is a great need in FSM for practical and reliable approaches that allow engineers to select and design appropriate treatment technologies. Presented here is how our research addresses these gaps. Linda Strande[1], Moritz Gold[1], Lars Schoebitz[1], Magalie Bassan[1]

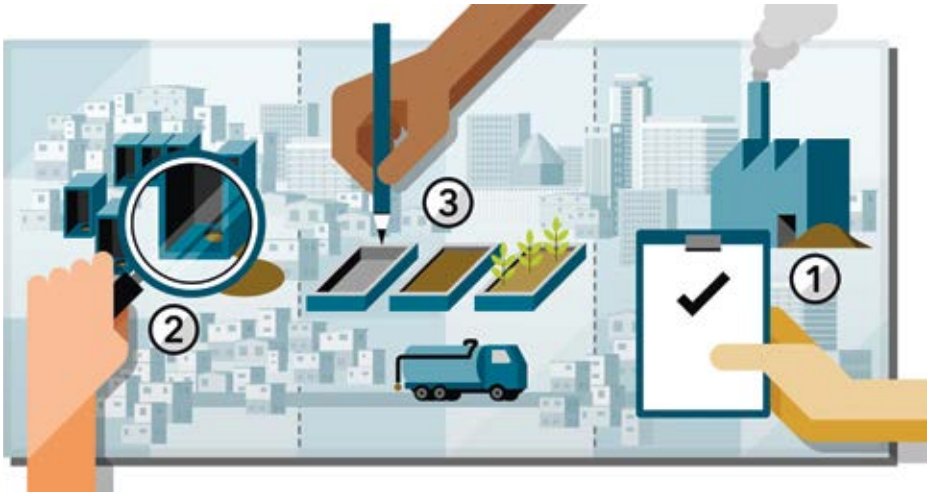

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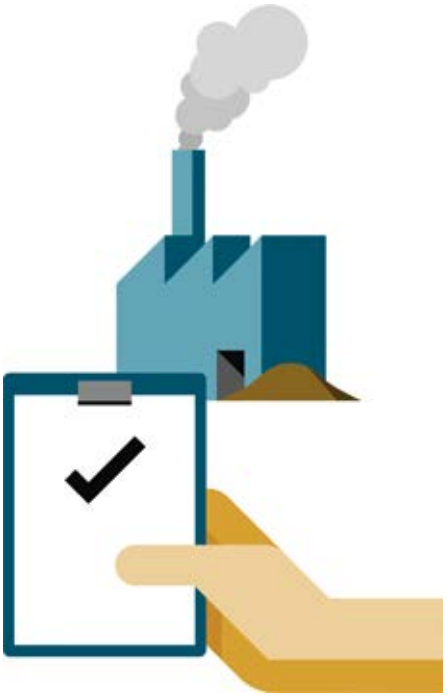
Figure 1. Schematic of Engineering Design Approach, including: 1) Treatment Objectives and Resource Recovery; 2) Faecal Sludge Quantification and Characterization; and 3) Treatment Technologies for Resource Recovery. (© Sandec)

Treatment Objectives and Resource Recovery



The definition of engineering design is the formulation of a plan that allows an engineer to build a product with a specified performance goal. Unfortunately, performance goals and the specific local context are all too commonly ignored in low-income countries when designing treatment technologies. Designing such technologies for resource recovery in low-income countries can provide a method to define the performance goals which need to be met, while at the same time increasing financial flows to offset treatment costs, and providing an incentive for the efficient operation of treatment plants. Designing for the specific enduse is critical, as under-designing treatment technologies do not provide adequate protection of human and environmental health, and over-designing wastes money and resources.

Depending on the form of resource recovery, the defined performance goals are quite different. For example, pathogen reduction in faecal sludge (FS) is not as important for its combustion as a fuel, whereas it is of utmost importance for FS use as a soil amendment with edible crops. The Market Driven Approach methodology was developed jointly between engineers and experts in economics and business development to assist in the identification of FS treatment endproducts that are appropriate for local contexts and have the largest market potential for volume and growth.

Our recent publications in this area are:

- Report: Market Driven Approach: Tool to aid in selecting treatment endproducts (2016)
- Paper: Market based selection of faecal sludge resource recovery: Field results from Uganda, Senegal and Vietnam (in preparation)
- Paper: A value proposition: resource recovery from faecal sludge – Can it be the driver for improved sanitation? (2014)

Faecal Sludge Quantification and Characterisation

Prior to the design of full-scale treatment plants, engineers first need to know the quantities and characteristics of the FS that will be treated. However, no reliable methods currently exist to determine the quantities and characteristics of FS on this scale. Reliable estimations are quite complicated due to the informal nature of FSM, and the high variability of FS characteristics. Research on understanding what will be delivered at treatment plants includes: identifying reliable predictors of FS characteristics, GIS analysis of collection and transport trucks, and reliable and reproducible standard methods for laboratory analyses.

Our recent publications in this area are:

- Paper: City wide characterization of faecal sludge in Hanoi: Influence of local factors (submitted)
- Paper: Reliable estimators for faecal sludge characterization on a city-wide scale: Towards developing methodologies (submitted)
- Paper: GIS tools for optimization of faecal sludge collection and transport at city-wide scale (submitted)
- Report: Results of faecal sludge analyses Kampala, Uganda: Pictures, characteristics and qualitative observations for 76 samples (2016)
- Report: Laboratory methods for the analysis of faecal sludge: 1. Vietnam (2016)
- Report: Laboratory methods for the analysis of faecal sludge (2016)
- Paper: FAQ: Faecal Sludge Quantification and Characterization – Field trial of methodology in Hanoi, Vietnam (2014)
- Paper: Characterization of Faecal Sludge in Dry and Rainy Seasons, Ouagadougou, Burkina Faso (2013)

Treatment Technologies for Resource Recovery

After the definition of performance goals and deriving estimations of FS quantities and characteristics, then treatment technologies can be designed. Because available space in urban areas is very limited, and most current FS treatment technologies are space intensive, our research in this area focuses on how to increase the treatment capacity of existing technologies. This can increase the amount of sludge treated, and/or reduce the required footprint of treatment plants, in addition to optimising technical aspects of resource recovery.

One of the most important treatment objectives in FSM is dewatering. FS is mainly comprised of water, and water is heavy and expensive to transport. Discharging polluted water into the environment also has significant negative impacts. Dewatering FS is required prior to its being used in resource recovery applications, such as composting or combustion as a fuel.

Our recent publications in this area are:

- Paper: Faecal sludge as fuel for brick production and oil regeneration in Sub-Saharan Africa (2016)
- Paper: Locally produced natural conditioners for dewatering of faecal sludge (2016)
- Paper: Identification of novel plant species for faecal sludge treatment and forage production in planted drying beds (2016)
- Paper: Technology development of unplanted drying beds for resource recovery from faecal sludge: Fuel production in Sub-Sahara Africa (2015)
- Paper: Fuel Potential of Faecal Sludge: Calorific Value Results from Uganda, Ghana, and Senegal (2014)
- Paper: Effect of hydraulic loading frequency on performance of planted drying beds for the treatment of faecal sludge (2014)
- Paper: Performance of Vertical Flow Constructed Wetlands for Faecal Sludge Drying Bed Leachate: Effect of Hydraulic Loading (2014)
- Paper: Results from FaME (Faecal Management Enterprises) – Can dried faecal sludge fuel the sanitation service chain? (2014)

Sustainable Implementation

Most importantly, one must keep in mind that the engineering design of treatment technologies is only one aspect of sustainable FSM! This also must include integrated planning and management schemes. For more information, please refer to the book, *Faecal Sludge Management: Systems Approach to Implementation and Operation,* which is available for no charge along with all our other publications at www.sandec.ch/fsm_tools.

Our recent publications in this area are:

- Paper: Success and failure assessment methodology for wastewater and faecal sludge treatment projects in low-income countries (2015)
- Paper: Looking beyond technology to provide adequate and sustainable sanitation in low income countries (2014)
- Paper: Integrated faecal sludge management scheme for the cities of Burkina Faso (2013)
- Paper: Technologies for sanitation: how to determine appropriate sludge treatment strategies in Vietnam (2014)
- Paper: Capital and Operating Costs of Full-Scale Faecal Sludge Management and Wastewater Treatment Systems in Dakar, Senegal (2012)
- Report: Capacity strengthening in sanitation: benefits of a research - operator collaboration (2011)

Figure 1. Faecal Sludge Management: Systems Approach for Implementation and Operation.

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