# Annex 1: Lime stabilisation

## Design

The adddition of either hydrated lime (Ca(OH)2) or quick lime (CaO) to faecal sludge increases pH and results in pathogen inactivation and limited sludge stabilization [M&E]. An alkaline environment is destructive for bacteria as cellular pH will increase to inhabitative levels and at pH levels greater than 12 cell membranes are completely destroyed [lactic acid]. The high pH also leads to an increased ammonia (NH3) concentration which will act as a biocide and contribute to pathogen removal if contained within a closed reactor [msc thesis]. The use of quick lime instead of hydrated lime will not only raise pH but also create an exothermic reaction that increases pathogen inactivation. After the initial reaction, pH will decrease over time and regrowth of bacterial pathogen can occur [FSM handbook].

Different combinations of pH and exposure times result pathogen removal, for example 120 minutes at pH 11 or 30 minutes at pH 12 (Strande et al., 2014). Field research has shown that faecal sludge from pit latrines treated at pH > 11.5 for a period of 2 hours meets WHO standards [WASTE]. However an increased pH of 12 for a period of at least two hours is required for US EPA class B biosolids and recommended in emergency settings [emergencies] [US EPA].

### Design parameters

Loading rate 4 m3/day assumption: 10,000 people, 0.4 l/person/day

Lime dosage rate 20 kg/m3 sludge typical range: 1 – 17 kg/m3 faecal sludge

Lime consumption 80 kg/day actual lime use 76 kg/day

The lime dosage rate of 20 g lime per kilogram faecal sludge was determined by jar testing and was validated by process measurements. In the period August – September the average lime dosage rate was 19 kg/m3. The actual dosage rate is comparable to the dosage rate for faecal sludge (10 – 17 kg/m3 faecal sludge) and varies significantly from the dosage rate for septage (1 – 5 kg/m3 septage). This difference indicates that the available lime is of limited qualilty, a concern also raised by Solidarites International [1]. A second contributing factor can be the the limited level of degradation in pit latrines.

## Construction

Sludge should be treated batch-wise in large tanks or ponds and extensive mixing is essential for an effective lime treatment process. [emergencies]. Good mixing of dry lime and sludge is difficult and standard procedure is to mix the dry lime with water to form a slurry, which is then mixed with the sludge. Poor lime mixing cannot be compensated by overdosing with lime [Practical Action].

At the FSM site lime treatment takes place in the 65L barrels that are used for transport. The lime treatment procedure is suitable for the current set-up with a relative small amount of faecal sludge transported to the FSM site by carriers. A pumped transport system would require a different set-up, including a large tank and mechanical mixing.

## Operation

Before desludging a 1:1 lime-water mixture is added to the barrel. Once the barrel is carried back to the site the content is stirred for approximately three minutes followed by pH measurement.

Lime is dosed at an average of 19kg/m3 faecal sludge and additional lime is added when a pH of 11.5 is not achieved. Initial pH after lime dosage is 11.8, two hours after lime dosage a pH of 12.1 is measured (treatment recordings August – September). The treated sludge meets WHO standards (pH > 11 for 2 hours) and potentially US EPA class B biosolids requirements (pH ≥ 12 for 2 hours).