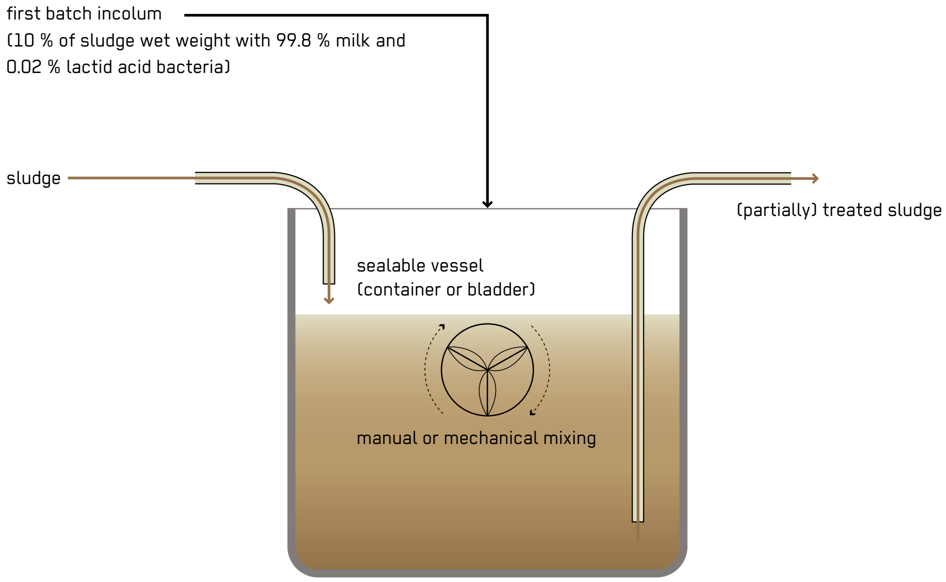
Lactic Acid Fermentation (LAF) Treatment (Emerging Technology)

Phase of Emergency	Application Level / Scale	Management Level	Objectives / Key Features
** Acute Response * Stabilisation Recovery	Household ** Neighbourhood City	Household Shared ** Public	Pathogen removal, Minimising immediate public health risks
Space Required	**Technical Complexity**	**Inputs**	**Outputs**
* Little	** Medium	● Blackwater, ● Sludge	● Sludge



Lactic Acid Fermentation (LAF) is a biological treatment option using lactic acid bacteria (LAB) with the ability to form significant quantities of lactic acid and thereby aid in inactivating pathogens in faecal sludge. LAB are easily obtainable and can be made from molasses, milk and probiotic drinks.

Lactic acid, in its dissociated form can penetrate cell membranes and inactivate and destroy pathogens. The inactivation of pathogens is triggered when the concentration reaches approximately 20–30 g of lactic acid per litre of faecal sludge. This corresponds to a lowering of pH; pH conditions of less than pH 4 induce pathogen inactivation.

Design Considerations: It is recommended that the LAF process is carried out under batch conditions in sealed vessels (container or bladder). The vessel size may vary depending on the amount and frequency of sludge generated. LAB is cultured in an inoculum before being added to the fresh sludge. The inoculum for the first batch is a mixture of milk (99.8 %) and LAB from, for example, Yakult (0.02 %) that has been mixed and stored at room temperature for 48 hours. For subsequent batches the treated sludge can be used as an inoculum. For the biological process, the inoculum is initially added to the tank in the ratio of 10 % of the overall sludge wet weight. The fresh faecal sludge is pumped into the vessel and recirculated to get a homogenous mix of fresh sludge and the inoculum. The sludge is then stored over a period of 2 weeks monitoring the pH daily to ensure a sanitised sludge is produced.

Materials: LAF Treatment needs a vessel, preferably sealable as LAB are most efficient under anaerobic conditions. However, LAB are aero-tolerant and therefore open tanks can be used if no sealed vessel is available. To achieve a homogeneous mix within the vessel a recirculation pump is required. The type of pump depends on the thickness of the sludge. For liquid sludge, a diaphragm pump may be used, whereas thicker sludge may need a screw pump or a vacuum pump. In addition, an initial supply of milk and a probiotic drink is needed to prepare the LAB molasses. To monitor the pH level and pathogens in the vessel a water testing kit is needed.

Applicability: LAF Treatment is considered an emerging technology that has not yet been widely used in emergency settings. However, first pilot projects and studies are promising and growing evidence suggests that LAF Treatment may be a suitable treatment option particularly for the acute response phase due to its short treatment time (around 2 weeks), a relatively simple process and use of readily available materials. It can be applied as an on-site treatment option for pit and trench latrines **(S.1, S.3, S.4)**.

Operation and Maintenance: Regular maintenance of pumps is required, especially due to the corrosive nature of the treated sludge. For each new batch of faecal sludge an initial amount of sludge from the previous batch should remain in the reactor vessel as an inoculant for LAB production in the sludge.

Health and Safety: Molasses, milk or the LAB do not pose any significant health risk. However, proper personal protective equipment (PPE) should still be considered when handling the treated sludge as the final product may not be sufficiently treated and may still contain pathogens.

Costs: LAF Treatment can be considered a relatively cheap treatment option. Costs may vary depending on the availability and costs of local materials. To treat 1 m^3 of faecal sludge an initial amount of 100 L of milk and 200 ml of a probiotic drink is needed. For subsequent batches the treated sludge can be used as the inoculum.

Social Considerations: PPE should be worn and training for involved staff is needed to ensure the proper functioning of the technology.

Strengths and Weaknesses:

(+) High reduction of pathogens (6 log removal of E.coli i.e. pathogen count is 1 million times smaller)
(+) Simple process which uses readily available material: molasses and LAB
(+) Produced sludge has a high lactic acid content (30 g/L) and can be used as inoculum for subsequent batches
(+) Medium treatment time ≈2 weeks (15 days)

(−) Biological process, therefore susceptible to environmental conditions
(−) High temperatures are required (30 °C optimum)
(−) Produced sludge is acidic (pH 4)
(−) No stabilisation occurs and additional post sludge treatment is required

→ **References and further reading material for this technology can be found on page 192**