Development of Trash Exclusion for Mechanized Pit Latrine Emptying

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1. Fecal sludge simulant rheology

Bentonite clay in water generally exhibits thixotropic properties (decrease in viscosity with increased shear rate), but it is not yet known if these properties behave similarly to fecal sludge. The preparation of the simulant consisted of mixing different amounts of bentonite clay (American Colloid Company, Hoffman Estates, IL) with water to achieve 3, 7, 9, 10 and 12% (by weight) bentonite slurries. The differing percentages of bentonite solids reflect thick and wet pits. Wet pits are defined as mean total solids content of the fecal sludge below or equal to 5% and reflect pits like septic tanks, cesspools, latrines in washing cultures, and latrines with showers. Dry systems in contrast have a mean total solids content above 10% and represent pit latrines without showers and pit latrines in wiping countries (Radford et al., 2015).

Dry bentonite needs sufficient time to hydrate and maintain consistent viscosity. Slump tests were performed to determine the needed bentonite slurry hydration time. A hollow polyvinyl chloride pipe (18 cm length and 8 cm internal diameter) was filled with bentonite slurry to the top and the pipe was quickly lifted from the surface. The diameter of the slurry circumference formed was recorded. This process was replicated 3 times. Tests showed that after

24 hours of hydration, the percent change in diameter decreased by less than 5% across the three replicates, which was considered acceptable for the purposes of this study.

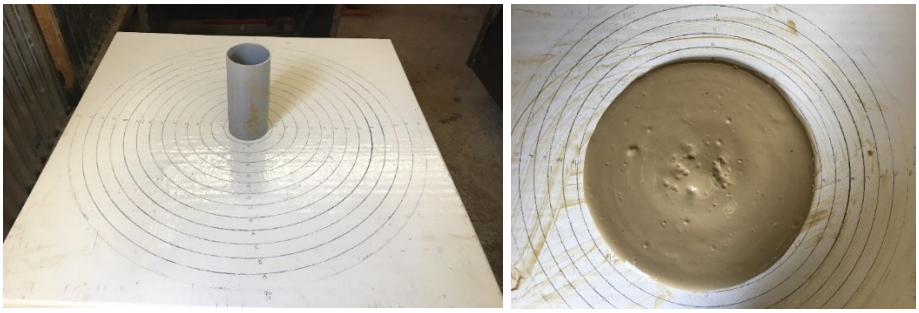

Figure 1. Slump test setup

A hybrid rheometer was used to analyze the change in viscosity with increasing shear rate of the different bentonite slurries. The change in viscosity with increasing shear rate of the different bentonite slurries indicated that bentonite slurry shear strengths varies from 0.001 to 1000 Pa which is in range of the documented shear strength of pit latrine fecal sludge of 0 to 2000 Pa as measured by penetrometry (Radford et al. 2015). The rheometer shows increasing bentonite concentrations having increasing viscosities, and show a slower viscosity increase above 9% bentonite. In fact, bentonite sludge of 9%, 10% and 12% behave similarly. The negative trend of the data of confirms the ability of bentonite to simulate the shear thinning (thixotropic) property of fecal sludge (Figure 2).

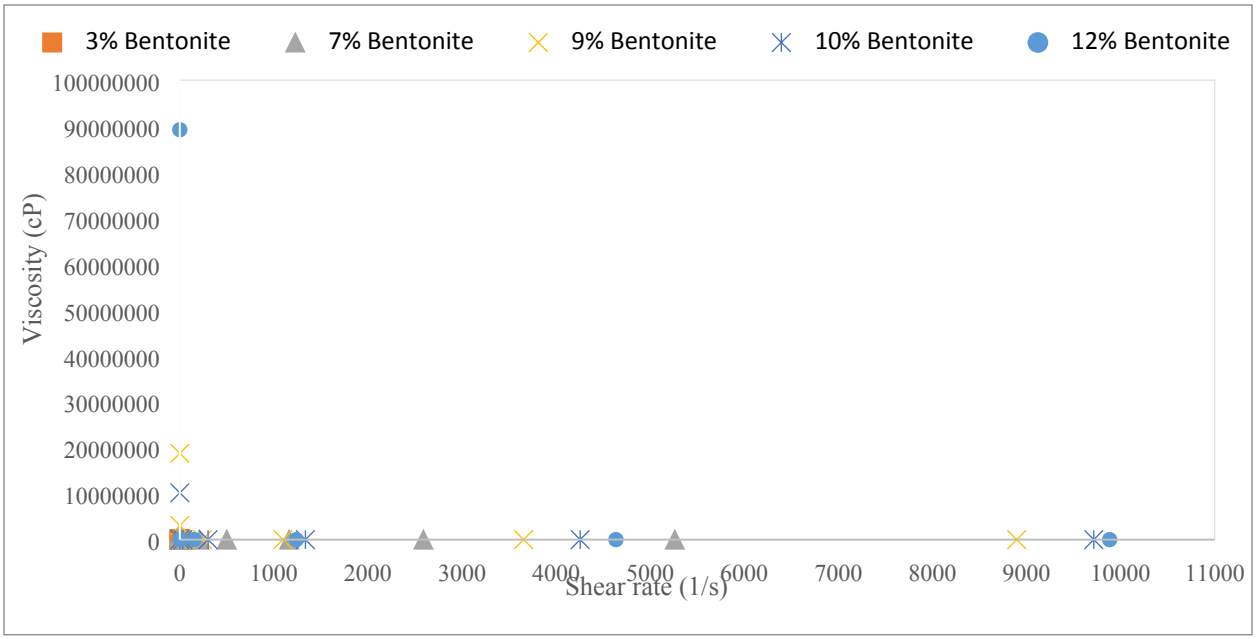

Figure 2. Rheometer results of different bentonite slurry strengths

2. Deflecting Head

Figure 3. A Deflecting Head where the auger and screen rotate together.

3. Clearing Head

Figure 4. A Clearing Head prototype. Under a clearing mechanism, the screen can either rotate about a stationary auger or an auger can rotate about a stationary screen.

4. Fibrous materials

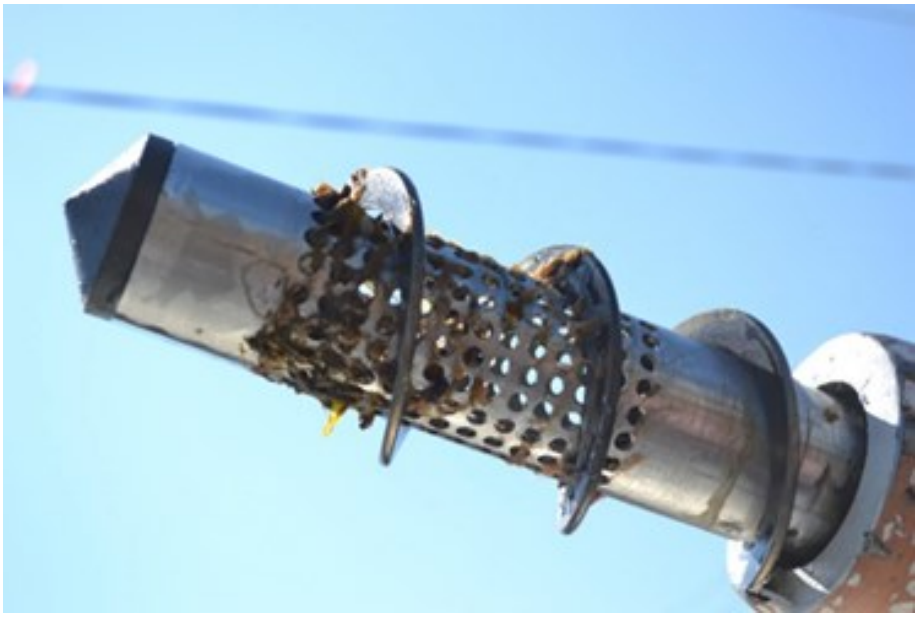

Figure 5. Vegetable fibers clogging the Modified Clearing Head