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# INVESTIGATION OF EFFECTIVENESS OF DRYING COW DUNG IN SAND DRYING BED

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**Abstract:** This study investigated the effectiveness of dewatering cow dung in sand drying bed as an alternative to the more expensive rotary dryer. Samples for the study were sewage sludge and cow dung. Drying was done in sand drying beds through seepage and evaporation and standard methods were used in conducting the experiments. Results show that initial moisture contents were 81.01% and 74.07% for sewage sludge and cow dung. Dewaterability ratio between sewage sludge and cow dung after 7 days and 13 days of drying were 0.821 and 1.03. Cow dung dewater faster through seepage than sewage sludge on short term basis by 17.92%, but on long term basis, better dewaterability of 2.99% was observed in sewage sludge. Cumulative moisture loss from evaporation is higher in cow dung than in sewage sludge by 2.88%, while final moisture content in sewage sludge was 0.050411m$^3$ and 0.052237 m$^3$ in cow dung. Overall percent moisture loss in sewage sludge was 55.55% and 53.94% in cow dung an indication of effective dewatering because of the insignificant difference between dewatering in sewage sludge and cow dung. It is concluded that sand drying beds can serve as better alternative to expensive cow dung rotary dryer.
**Keywords:** cow dung, drying bed, effectiveness, investigation

## 1. INTRODUCTION

Sewage sludge is a problem because of pollution of the environment. Annually, about 850,000 tons of dry sludge were generated in 1998 which is expected to increase to 1,300,000 tons in the year 2005 globally (Arlabosse et al., 2004). In line with strict environmental regulations, there has been a rapid global increase in the generation of sewage sludge from wastewater treatment facilities (Spinosa, 2001; Duenser, 1996). Sewage sludge is watery, it contains 2% solids and 98% water so that water removal is important for volume reduction and ease of handling which can be achieved by gravity thickening or air floatation as an alternative (Agunwamba, 2001). Sand drying beds are relatively inexpensive and provide dry sludge cake (Obianyo & Agunwamba, 2015). However, dewatering of various types of water from sludge have been studied by many researchers such as (Robinson & Knocke, 1994; Smith & Vesilind, 1995; Jantet et al., 1996; Chen et al., 1996; Kajoie et al., 2000). Due to high demand for meat, milk and hides, the quantities of cow dung generation have increased appreciably and have resulted in indiscriminate disposal of cow dung and associated environmental problem (Olaoye et al., 2018). Huge volumes of cow dung are generated from cattle ranches, slaughterhouses, feed lot farms and are disposed indiscriminately without treatment (Adeshiyan et al., 2010; Oyeleke, et al., 2003). There has been increase in generation of animal wastes such as urine, faeces, bedding, litter, feed remains, wastewater that is highly contaminated by animal manure bedding, wastes from washing and cleaning of animal pens and facilities for processing of animals (FAO, 1990). In space-constrained livestock settings, large quantities of animal wastes produced because serious environmental problems if indiscriminately disposed (Morse, 1995; Hammond, 1997). Runoff from animal wastes facilities may flow into water bodies and being rich in nitrogen, phosphorous and potassium can give rise to eutrophication giving rise to algal bloom which result in suffocation and consequent disorganization of aquatic ecosystem (Anderson et al., 2002)

Treatment of cow dung by electrical drying requires power supply and hence expensive. It is speculated that sand drying beds could be a better alternative since it requires natural factors such as solar radiation for heating and subsequent evaporation and seepage losses through drains. This investigation could only be realistic if dewatering of cow dung is compared with sewage sludge in model sand drying beds.

Therefore, the objective of this study was to investigate the effectiveness of drying cow dung in sand drying bed in order to save cost since drying beds are cheaper in treating sludge. Results from this study would enable waste managers to make decision as in whether it is expedient to replace the conventional electrical heating systems used in drying cow dung with sand drying beds in the treatment of cow dung.

## 2. MATERIALS AND METHOD

### — Experimental Set-up and Procedures

Known quantities of samples of sewage sludge and cow dung were oven-dried at a temperature of 105°C to determine the initial moisture contents of the samples in accordance with BS 1377 (1975). Consistency analysis was carried out to make the two samples have the same initial condition as shown below before introduction into drying beds. The drying bed is a simple sand and gravel filters on which batch loads of sludge are dewatered. The gravel layer with particle sizes of diameter in the range of 7 – 15 mm of 200 mm thickness. On top of the gravel layer is the sand layer of grain sizes ranging from 0.2 – 0.6 mm which has a 200 mm thickness.

The final layer is the sewage sludge and cow dung each of 300 mm thick. The model drying bed 1000 mm long, 300 mm wide and 800 mm overall depth. The underdrain is 50 mm diameter which extended through a 50 mm diameter drain pipe, and provision of a 50 mm overboard. Sewage sludge and cow dung were simultaneously applied on the beds intermittently and the discharges were collected on daily basis. Evaporation from the bed were measured with Pitche atmometer which were placed inside the 300 mm wide and 1000 mm long drying beds, partially covered with polyethylene bag in order to permit solar radiation into the bed for drying to effectively take place. Schematic diagram for seepage and evaporation losses in drying beds of sewage and cow dung is shown in figure 1.

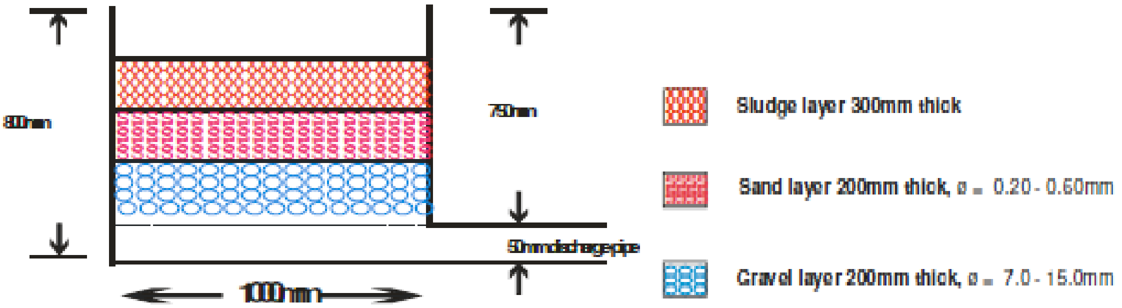


Figure 1: Schematic diagram of sand drying bed

— Consistency Analysis

Consistency analysis was the first operation carried out prior to seepage and evaporation experiments. A comparison was made between dewaterability in sewage sludge and cow dung. These sludge have different sources, and of course different moisture contents and therefore must be made to have the same initial conditions for effective comparison since the objective of this study was to investigate the effectiveness of dewatering of cow dung using sand drying beds viz;

- ≡ Weight of cow dung used in the experiment = 45.00kg
- ≡ Moisture content = 74.07%
- ≡ Percent solid = 100 – 74.07 = 25.73%

For 45.00 kg cow dung, solid content will be $\frac{25.73}{100} \times 45 = 11.58$ . Water content = 45 – 11.58 = 33.42kg.

Equivalent 45 kg of sewage sludge based on 81.01% moisture content will contain 100 – 81.01 = 18.99% solid.

45kg of sewage sludge will contain $\frac{8.99}{100} \times 45 = 8.55$

Solid content < 11.58kg for cow dung. Water content = 45 – 8.55 = 36.45 kg of water. Since cow dung contains 11.58kg of solid, sewage sludge should contain equal amount of solid for effective comparison. Therefore, equivalent weight of sewage sludge that will contain 11.58kg solid will be viz;

8.58kg of sewage sludge contains 36.45kg of water. 11.58kg of sewage sludge will contain $\frac{11.58}{8.55} \times 36.45 = 49.37$ kg of water

Weight of sewage sludge = weight of solid + weight of water. Weight of sewage sludge = 49.37 + 11.58 = 60.95kg

For cow dung, add 80.00kg of water. Total water content in cow dung = 33.42 + 80.00 = 113.42 kg. For sewage sludge, 49.37 – 33.42 = 15.95 kg excess water when compared with water content in cow dung.

Therefore, 80 – 15.95 = 64.05 kg of water to be added to sewage sludge for both samples to have the same initial condition.

## 3. RESULTS AND DISCUSSION

— Moisture Content Tests

Moisture contest test was performed in accordance with BS1377(1975). The essence of moisture content test was to determine the initial moisture contents of sewage sludge and cow dung samples. Results obtained will be used to carry out consistency analysis in order to bring the two samples to the same initial conditions for effective comparison and reasonable inference, decision and conclusion that are not misleading. Results of moisture content tests are presented in Table 1.

Table 1: Moisture contents of sewage sludge and cow dung

| Sample | Wt. of can(g) | Wt. of can + wet sample(g) | Wt. of wet sample(g) | Wt. of dry sample(g) | Wt. of water (g) | Moisture content (%) |
|---|---|---|---|---|---|---|
| Sewage sludge | 18.5242 | 20.5397 | 2.0155 | 0.3827 | 1.6328 | 81.01 |
| Cow dung | 17.6926 | 19.6939 | 2.0013 | 0.5189 | 1.4824 | 74.07 |

Table 2: Results from consistency analysis

| Sample | Solid content(kg) | Water content (kg) | Quantity of water added (kg) | Total quantity of water in sample (kg) | Grand total weight of sample (kg) |
|---|---|---|---|---|---|
| Sewage sludge | 11.58 | 49.37 | 64.05 | 113.42 | 125.00 |
| Cow dung | 11.58 | 33.42 | 80.00 | 113.42 | 125.00 |

The rate at which seepage is taking place is faster in cow dung than in sewage sludge. Seepage stopped after 7 days in cow dung but continued up to 13 days in sewage sludge showing that sewage sludge has higher potential to retain water. This appear to depend on the type diet taken by man being an omnivorous animal and cattle, a herbivorous animal. In figure 1, it can be seen that seepage in cow dung was very high at the initial stage and dropped appreciably after the seventh day while in sewage sludge it was gradual from inception to the end of thirteenth day. Referring to Table 3, dewaterability ratio between sewage sludge and cow dung after 7 days was 0.821, while on a holistic basis, dewaterability ratio between sewage sludge after 13 days and cow dung after 7 days was 1.03.

Table 3: Results of seepage and evaporation losses from sand drying beds

| Parameter | Sewage sludge | Cow dung | Dewatering ratio | % Difference |
|---|---|---|---|---|
| Initial moisture content ($m^3$) | 0.113420 | 0.113420 | NA | NA |
| Cumulative water loss from seepage after 7 days | 0.049362 | 0.060142 | 0.821 | 17.92 |
| Cumulative water loss from seepage on holistic basis ($m^3$) | 0.061998 | 0.060142 | 1.030 | 2.99 |
| Cumulative water loss from evaporation ($m^3$) | 0.001011 | 0.001041 | 0.970 | 2.88 |
| Final moisture content ($m^3$) | 0.050411 | 0.052237 | 0.965 | 3.496 |
| Moisture loss ($m^3$) | 0.063009 | 0.061183 | NA | NA |
| Per cent moisture loss (%) | 55.55 | 53.94 | NA | NA |

NA – Not applicable

These results indicate that cow dung dewater faster through seepage losses than sewage sludge on short term basis by 17.92%, but on long term basis, sewage sludge experienced higher dewatering capacity though by a little margin of 2.99%.

Results from figure 2 show that evaporation is higher in cow dung with cumulative evaporation of 0.001041 $m^3$, while in sewage sludge, cumulative evaporation was 0.001011 $m^3$ with 2.88% difference. However, final moisture content for both sewage sludge and cow dung were 0.050411 $m^3$ and 0.052237 $m^3$ respectively an indication that moisture loss is higher in sewage sludge than in cow dung by 3.496% which is insignificant. In Table 3, overall moisture loss in sewage sludge and cow dung were found to be 55.55% and 53.94% respectively. These results evidenced that cow dung can be treated in sand beds since 53.94% of water was removed after 13 days of drying.

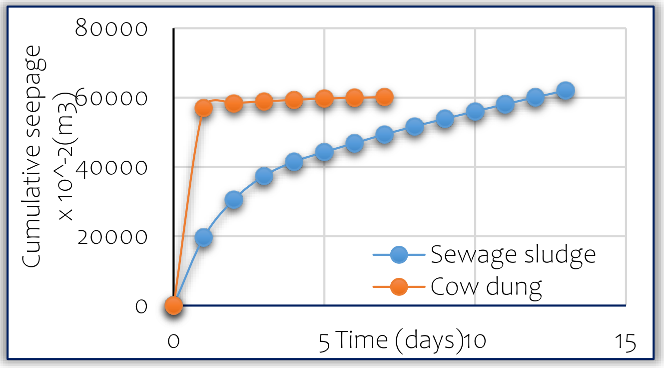


Figure 1: Relationship between cumulative seepage and time

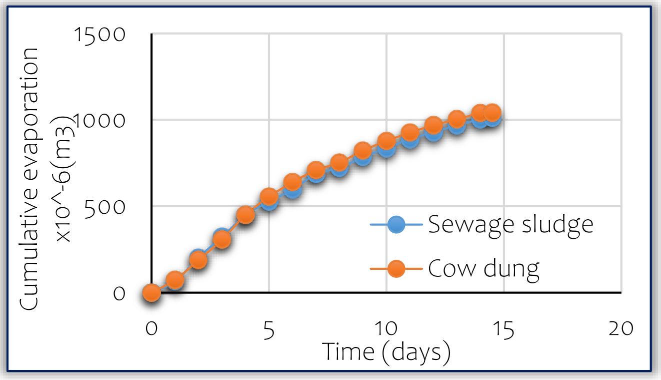


Figure 2: Relationship between cumulative evaporation and time

## 4. CONCLUSION

This study investigated the effectiveness of treating cow dung wastes by using sand drying beds. The essence is the possibility this alternative when compared with the conventional methods of heating cow dung which requires energy and increased costs. Conclusively, results indicated that sand drying beds are better alternatives for treating and drying of cow dung wastes. This firm conclusion stem from the results of the study which indicated 53.94% overall water loss from cow dung and 55.55% overall water loss from sewage sludge.

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