Waste Management 46 (2015) 472–479

Contents lists available at ScienceDirect

Waste Management

journal homepage: www.elsevier.com/locate/wasman

Improved compaction of dried tannery wastewater sludge

M. Della Zassa [a], M. Zerlottin [b], D. Refosco [b], A.C. Santomaso [a], P. Canu [a,*]

[a] Dept. of Industrial Engineering, University of Padua, Via Marzolo, 9, 35131 Padova, Italy
[b] Acque del Chiampo S.p.A., Via Ferraretta, 20, 36072 Arzignano (VI), Italy

ARTICLE INFO

Article history:
Received 23 May 2015
Revised 24 August 2015
Accepted 26 August 2015
Available online 31 August 2015

Keywords:
Thermal treatments
Dry sludge
Solid waste management
Apparent density
Waste densification
Pelletization

ABSTRACT

We quantitatively studied the advantages of improving the compaction of a powder waste by several techniques, including its pelletization. The goal is increasing the mass storage capacity in a given storage volume, and reducing the permeability of air and moisture, that may trigger exothermic spontaneous reactions in organic waste, particularly as powders. The study is based on dried sludges from a wastewater treatment, mainly from tanneries, but the indications are valid and useful for any waste in the form of powder, suitable to pelletization. Measurements of bulk density have been carried out at the industrial and laboratory scale, using different packing procedures, amenable to industrial processes. Waste as powder, pellets and their mixtures have been considered. The bulk density of waste as powder increases from 0.64 t/m^3 (simply poured) to 0.74 t/m^3 (tapped) and finally to 0.82 t/m^3 by a suitable, yet simple, packing procedure that we called *dispersion filling*, with a net gain of 28% in the compaction by simply modifying the collection procedure. Pelletization increases compaction by definition, but the packing of pellets is relatively coarse. Some increase in bulk density of pellets can be achieved by tapping; vibration and dispersion filling are not efficient with pellets. Mixtures of powder and pellets is the optimal packing policy. The best compaction result was achieved by controlled vibration of a 30/70 wt% mixture of powders and pellets, leading to a final bulk density of 1 t/m^3, i.e. an improvement of compaction by more than 54% with respect to simply poured powders, but also larger than 35% compared to just pellets. That means increasing the mass storage capacity by a factor of 1.56. Interestingly, vibration can be the most or the least effective procedure to improve compaction of mixtures, depending on characteristics of vibration. The optimal packing (30/70 wt% powders/pellets) proved to effectively mitigate the onset of smouldering, leading to self-heating, according to standard tests, whereas the pure pelletization totally removes the self-heating hazard.

1. Introduction

Several solids waste materials are available as particles, possibly with a broad size distribution, spanning from submillimiter fines to centimeters. This is very common for industrial wastes. A very broad category includes sludges after drying. The most common source of sludge is wastewater treatment, where they are unavoidable byproducts. Difficulties in effective sludge disposal may become the bottleneck for the whole water treatment process, and even propagate upstreams, jeopardizing the activities that require the wastewater treatment. Sludge production can be reduced by properly operating on the water treatment process (Khursheed and Kazmi, 2011). Further reduction of the sludge mass requires water removal, calling for extra energy input. Dewatering achieves an average solids contents of 25–30 wt%. Dewatered sludge must find environmentally compatible use, otherwise its landfilling can determine significant leachate production with groundwater pollution hazard (Allen, 2001). Further, sludge produced from some industrial wastewater can be even more problematic, because of metal and biodegradation limiting species. This work addresses a general issue with reference to a specific sludge, produced by treatment of effluents dominated by tannery wastewater. In this case, dewatered sludge is even refractory to fermentation. It cannot be easily incinerated, because some constituent may lead to very toxic airborne emissions. It is then dried, removing a significant amount of mass as water, and disposed as individual big-bags, in a dedicated landfill (Zerlottin et al., 2013). Water removal by thermal treatments is a very effective method to reduce the mass and size of a waste. Drying can be carried out with a number of technologies, where the key factor is the heat transfer method (convective or conductive). Often a low oxygen environment must be maintained, to prevent undesired explosions. Tannery sludges, like other kind of industrial sludges,

* Corresponding author.
E-mail address: paolo.canu@unipd.it (P. Canu).

http://dx.doi.org/10.1016/j.wasman.2015.08.038
0956-053X/