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Name of the Title: Stabilization of Tannery Sludge through Brick Production

Introduction

Leather industry in Bangladesh is considered as one with considerable growth and investment potential, earned $1.29 billion from exports in the 2013-14 fiscal which accounts for 4.2 percent of the country's total exports (Hashem et al. 2015). The 113 tanneries which are mostly situated at Hazaribagh area, produce 180 million square feet of hides and skins per year and they generate about 20,000 m^3 of wastewater containing 2500-12500 mg/l suspended solid (HUFFER and TAEGER 2004). In wastewater treatment process, different chemicals are added and most of the chemicals get settled out during the process. Finally they end up in the sludge. Due to inherent nature of training process the tannery wastewater contains a large amount of suspended solids, resulting in generation of sludge in effluent treatment plants. About 100-150 kg of dry solid matter is generated per ton of hides/skins processed (UNIDO 1998). In Bangladesh 85000 tons of wet salted hides and skins are processed annually and it is estimated that 19000 tons of partially dried (50%) sludge will be generated by the effluent treatment plants if all tanneries treat effluent. In conventional physic-chemical cum biological treatment system 70-80 per cent of the sludge is produced in the primary treatment and the remaining 20-30 per cent is produced in the secondary biological treatment. The solids content in the tannery effluent will depend upon the raw material, type of process adopted, chemicals used in the process and other in-plant control measures. The main sources of suspended solids generation are first soaking, liming and vegetable tanning that too if carried out in pits using crushed barks and nuts. Tannery sludge, an unwanted solid residual from the tannery wastewater treatment plant, has the potential to contaminate soil, surface water and groundwater by generated leachate and pose a threat to the environment and natural resources if the sludge is not disposed properly (Thomson et al. 1999). Tannery sludge contains elevated concentrations of heavy metals like As, Cr, Co, Ni, Cu, Zn, Fe, C dude to use of basic chromium salt, different syntans, dyes, pigments, retaining agents etc. in the tanning process. These heavy metals are very harmful, because of their non-biodegradable nature, long biological half-lives and their potential to accumulate in biological systems (Manahan 2005, Wilson and Pyatt 2007, Singh et al. 2004). A technique to treat or stabilize hazardous waste is by solidification in construction materials such as brick or concrete which has been applied in several instances for the cases of sewage and textile sludge and arsenic-rich filter materials (Cusido oand Cremades 2012, Rouf and Hossain 2003). Several studies have shown that this technique can be applicable for tannery sludge as well (Basegio et al. 2002). The solidified product may be disposed off to a secured landfill site or it can be recycled as construction materials if it meets the specific strength requirement and can be shown to leach toxic pollutants within acceptable limits (Rahmat 2001).

Specific research objectives

- To assess the environmental viability of stabilization of heavy metal present in tannery sludge by solidification with clay mix in brick production.
- To assess the effect of using sludge (with the clay mix) on the strength and other physical properties of brick.
- To propose an optimum clay-sludge mix proportion that can be used for brick manufacturing paving way towards environment friendly recycling of toxic solid wastes.
- To compare and analyze the quality of sludge-incorporated bricks prepared in a commercial brick company in filed condition with respect to those prepared under laboratory conditions.

The objectives of the study were to investigate the tannery sludge management through brick production. Since Bangladesh is a developing country brick s are used in a large extent for the building construction. To meet the demand of millions and millions of bricks, a large number of brick fields have been established and increasing day by day. For this reason a tremendous pressure are falling on soil for raw materials of bricks resulting the reduction of agricultural fields. So the tannery sludge can be vital substitute of solid to some extent for the brick production which on the other hand, will reduce the environmental burden regarding sludge disposal. Different measurements of both clay – sludge mixture and bricks were carried out to evaluate the factors that could affect brick quality.

Major findings

- The pH of sludge samples ranged between 7.4-7.8. The moisture content of the sludge samples ranged between 60%-76% and high organic content ranges from 24.75% to 33.53%.
- Among the seven heavy metals As, Pb, Ni, Cd and Ni found within the safe limit set by India, China and USEPA. Cu exceeded the safe limit of India and China but below the USEPA limit put Cr content (19229 mg/kg) exceeded all permissible limits to apply in agricultural fields (Table 4.1).
- TCLP test of sludge indicated that leaching of chromium from sludge is more than other heavy metals but well below the USEPA TCLP limit and characterized as non hazardous waste.
- Atterberg limit test indicate that plasticity index of clay-sludge mixture reduces with increasing sludge addition and up to 20% of sludge can be applied to brick making without losing the plastic behavior.
- The results of compressive strength tests on the bricks indicate that the strength is greatly dependent on the amount of sludge in the brick and the firing temperature. The optimum amount of sludge that could be mixed with clay to produce good bonding of bricks was 10% by weight firing at 950^0C, produced B Grade bricks according to BDS 208 (1980).
- The brick manufactured did not show any deformation or uneven surfaces occurring at all firing temperatures with OMC applied in the mixtures of varying proportions. Increasing the firing temperature and decreasing the amount of sludge in the brick resulted in a decrease in water absorption.

- In order to yield a good quality brick, the proportion of sludge and the firing temperature are the two key factors controlling the shrinkage in the firing process. The percentage of shrinkage increases with the increasing sludge addition and bricks containing 20% sludge fire at 900-950^{0}C meet the maximum 8% firing shrinkage requirement.
- Increasing the percentage of sludge resulted in an increase in brick weight loss. The bricks made for this study all meet the criterion of 15% weight loss on ignition except 40% sludge criteria.
- The bulk density of brick was seen to be inversely proportional to the quantity of sludge added in the mixture. This finding was closely related to the quantity of water absorbed in the brick. When bricks absorb more water, it exhibits a large pore size than one with less water absorption. As a result bulk density becomes smaller.
- Firing temperature is a very important factor affecting leachability of heavy metal high firing temperature greater than 950^{0}C reduced the leaching of Cr and Cu. In case of other metal, leaching is insignificant. It was observed that leaching of Cr and Cu increase with increasing of sludge addition up to 20% but leaching is independent of sludge content in between mix proportion of 20% to 40%. However up to 20% (by weight) sludge along with clay can be used as raw materials for brick production without causing any environmental burden.

For more information on this research, please contact the National Resource Centre, NGO Forum for Public Health, E-mail: nrc@ngof.org