ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Utilization of Coovam Drain Canal Sludge for the Manufacture of Clay Brick.

S Thenesh Kumar[1], H Sekar Babu[2] and D Priyadharisani[2].

[1]Department of Chemical Engineering, S.R.M. University, Tamil Nadu, India.
[2]Department of Bio Technology, Vel Tech High Tech Dr.Rangarajan Dr. Sakunthala Engineering College, Chennai, Tamil Nadu, India.

ABSTRACT

Bricks produced from sewage sludge in different compositions were investigated. Results of the tests indicated that the sludge proportion is a key factor in determining the brick quality. Increasing the sludge content results in a decrease in brick shrinkage, bulk density, and compressive strength. Brick weight loss on ignition was mainly due to the contribution of the contained organic matter from the sludge being burnt off during the firing process, as well as inorganic substances found in both clay and sludge. The physical, mechanical, and chemical properties of the bricks were studied with various proportions of dried sludge from 5 to 45 wt%. It is evident from the results that 30 wt % and sludge can be used for manufacturing of clay bricks for load bearing portions of the building whereas 30-45 wt% of sludge combination bricks are recommended non load bearing partions of the building. This type of work will certainly form a base to utilize the stinking sludge to control pollution.

Keywords: Sewage sludge, Clay bricks, Reusability

Corresponding author

ISSN: 0975-8585

INTRODUCTION

Municipal wastewater sludge has become culture zone for many pathogenic microorganisms hence it has become a great challenge for the government authorities. Government had introduced many schemes to purify the waste water but it was in vain because of requirement of heavy funds. Therefore, disposal of sludge from wastewater treatment plants (WWTPs) is a problem for any municipality. The problem of sludge disposal will intensify as the amount of sludge produced increases. Eventually, finding the appropriate location for land filling will be a major problem in India because the amount of sewage produced is steadily increasing with increase in population. This sewage comprises various pollutants from domestic, commercial, and industrial premises. Therefore, alternative ways to reuse or to incorporate several types of waste materials have been attempted in recent decades, including incorporation into building materials [1]. Heavy clay ceramic materials, namely bricks and roof tiles, or floor tiles, are generally very heterogeneous, because they consist of natural clays with a very wide ranging overall composition [10]. Hence the present work has been designed to study the recycling ability of a sludge generated from sewage treatment plants [7].

MATERIALS AND METHODS

Wet sludge collected from main drain canal of coovum of Chennai. Clay sample of normal brick was obtained from a local brick manufacturing plant [G.V.Bricks] to prepare sludge-amended clay bricks using hand mold in the laboratory. Both clay and sludge samples were oven dried at 105°C for 1 and 2 days, respectively. After oven drying, these samples were then ground to pass through a 5-mm test sieve to be used as raw materials to make the test specimens [2]. The mixtures, as shown in Table 1, were then introduced into brick molds (with internals of 220 x 107.5 x 70mm). Sludge-free mixtures were also made for reference. The sludge-amended clay bricks were hand-molded by compaction using a rammer [4]. Wet bricks were then dried in the drying chambers of a local factory at approximately 150°C for 85 h. The molded mixtures were then fired in a continuous kiln with temperatures from 150°C to a peak temperature of approximately 985°C over a 12h period.

Table 1: Mass of raw materials required per brick for different proportions of clay–sludge mixtures

Sludge in clay brick (wt%)	Mass of raw materials required as per brick (g)		
	Clay	Dried sludge	Total
0 (Control)	2600	0	2600
10	2340	260	2600
15	2220	380	2600
20	2080	520	2600
25	1890	610	2500
30	1610	690	2400
35	1590	810	2400
40	1420	880	2300
45	1320	980	2300

Finally, they were cooled by thermal regulation of the kiln for 16h to ambient temperature. Given the intended use of bricks in building construction, testing should ensure that bricks have all the required characteristics for efficient use in building. The produced bricks then underwent a series of tests including firing shrinkage, weight loss on ignition (LOI), water absorption, bulk density, and compressive strength to determine the quality of bricks as specimens (Table 2)[8].

Table 2: Physical and chemical properties of clay and sludge

Property	Clay	Sludge
Moisture content (% dry mass)	3.5	106.9
pH	4.67	4.32
Particle density (g/cm3)	2.70	2.02
Atterberg		
Liquid limit (%)	41	70
Plastic limit (%)	24	NA
Plasticity index (%)	17	NA
Particle size distribution Size fraction (%)		
Gravel	15.40	-
Sand	20.85	37.85
Silt	33.30	60.00
Clay	30.45	2.15
Calorific value (kJ/kg)	NA	3137

RESULTS AND DISCUSSION

Sludge exhibits wide variations in physical, chemical, and biological properties according to place of origin, type, previous treatment, and period of storage. Presumably, its composition also varies with time. Therefore, sludge analyzed in this study was anticipated to give characterization results that differed from the corresponding values determined in other studies. Table 2 shows the physical properties for clay and sludge that were used in the study[9].

Water absorption

The degrees of firmness and compaction of bricks, as measured by their water absorption characteristics, vary considerably depending on factors such as the type of clay and methods of production used[3]. Low water infiltration into the brick indicates good durability of the brick and resistance to the natural surroundings. Therefore, the internal structure of the brick must be strong enough to avoid the intrusion of water. Figure 1 show that the water absorption of the bricks increases from 24.82% to 39.67% dry mass with increased sludge addition between 0 and 45wt% and therefore leads to decreased resistance to weathering. As shown earlier, plastic limit values have revealed that with the addition of sludge, the plastic nature of the mixture is lowered and the bonding ability of the mixture is also decreased. When the mixture contains high amounts of sludge, the adhesiveness of the mixture will decrease and the internal pores of the brick will increase. As a result, the quantity of water absorbed increases.

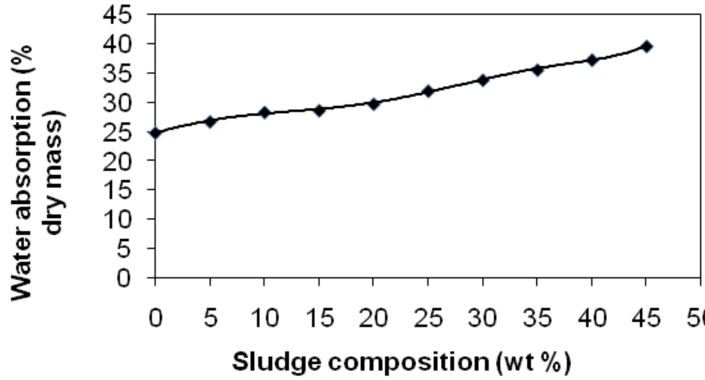

Figure 1: Effect of sludge composition on the water absorption of bricks

Linear firing shrinkage

Shrinkage during firing is unavoidable. Firing shrinkage in this study did not increase as reported by Alleman[2] but decreased with higher sludge addition as shown in Fig. 2 However, a decrease in firing shrinkage of bricks was reported by Ang in 1982, who utilized up to 50wt% fired sludge[6]. Hence, the decreasing trend obtained here may be due to the non-plasticity of the dried sludge amended into the clay bricks, which had a more profound effect on the bricks after being subjected to firing in the kiln. Furthermore, this study used dried sludge where the moisture had been driven out during the drying process, prior to it being mixed with clay as can be seen in Table 1. The water content was therefore largely derived from the clay. As the amount of dried sludge increased, the amount of clay used decreased and hence the amount of water content also decreased. Thus, this will contribute to the decrease in the linear firing shrinkage. Fortunately, the firing shrinkage values obtained for all control and amended bricks were considerably below the desirable firing shrinkage limits of 6% to 8%.

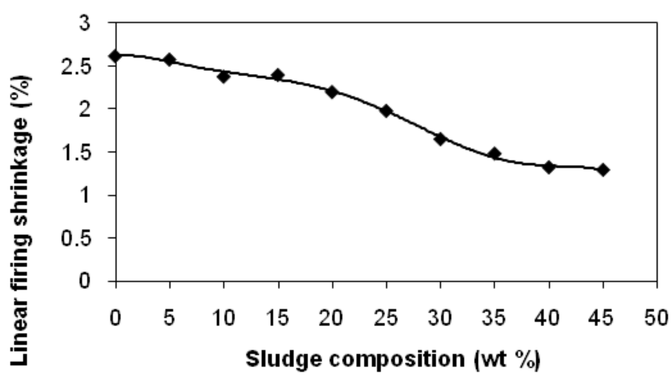

Figure 2: Effect of sludge composition on linear firing shrinkage

Weight loss on ignition

Figure 3 shows the effect of sludge proportion on the weight loss on ignition of bricks after firing. The brick mixtures with 30% sludge and below, met all the given criteria. Esthetically, the surface texture of the bricks was uneven with the appearance of many pores, thereby ruling out their use as facing bricks. This was due to the increase in the degree of surface roughness with sludge added to the bricks. They were, however, attractive because they appeared to be light red in color. It was expected that the formation of the rough texture was mainly due to organic matter being burnt off during the firing process.

As shown, upon the addition of sludge in the mixture, the loss of weight apparently increased due to the contribution of the organic matter in the sludge as well as inorganic substances found in both the clay and sludge.

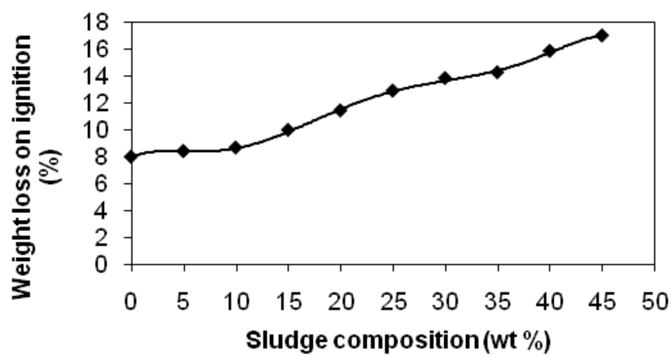

Figure 3: Effect of sludge composition on weight loss on ignition after firing

Compressive strength

All construction materials must resist stress resulting from dead and imposed loadings of buildings. The strength of a material, in general terms, is its ability to resist forces at failure. Because the strength of dry bricks is obviously higher than that of wet bricks, the former was immersed in water before testing to subject the bricks to a more severe condition[2].

The compressive strength was measured using an automated compressive strength test machine (Unit Test Scientific ADS 300/10F). The results are shown in Fig. 4 and indicate that the strength is greatly dependent on the amount of sludge addition in the brick. The compressive strength results given in the Fig. 4 range from 12.82N/mm^2 for the 5% sludge bricks to 2.03 N/mm^2 for bricks with 45% sludge. Figure 4 also shows that the addition of 5% sludge causes a 26% decrease in strength as compared with the control specimens. Additions of up to 20wt% sludge conformed to the minimum strength of 5.2N/mm^2 for use as load bearing bricks in one- and two-storey dwelling houses, and as load bearing internal walls. For non load bearing partitions with a minimum required strength of 1.4N/mm^2, bricks with up to 45wt% sludge can be used. However, bricks with more than 30wt% sludge are not recommended for this latter purpose simply because they were brittle and easily broken even when handled gently[5].

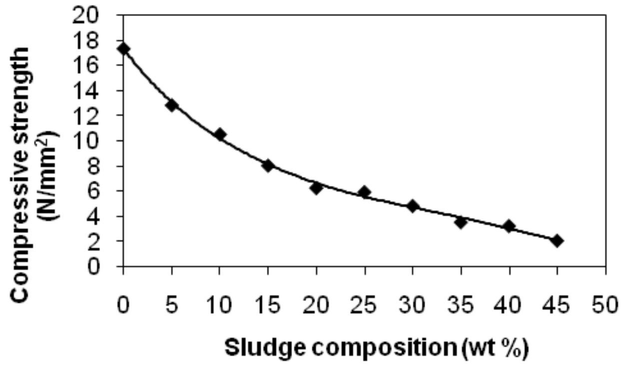

Figure 4: Effect of sludge composition on compressive strength

Bulk density

A figure 5 shows that the bulk density of the bricks is inversely proportional to the quantity of sludge added in the mixture. At 5wt% sludge, the density of the bricks was 2.56g/cm^3 and was reduced by 2.19g/cm^3 for 45wt% sludge bricks when compared with the density of control bricks prepared in this study. This downward trend was due to the associated loss of constitutive water and organic matter from the incorporated sludge in the bricks that were subjected to firing in the kiln, thus creating pores or voids. With higher sludge addition, more voids were created in the brick after firing.

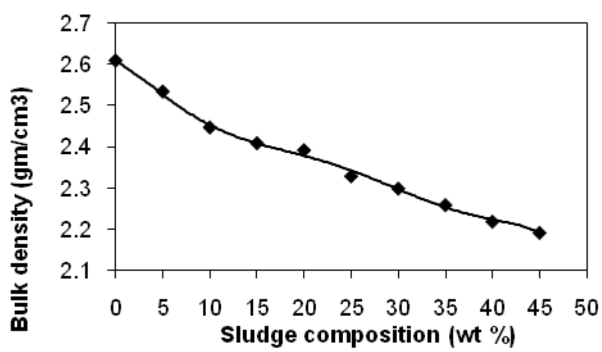

Figure 5: Effect of sludge composition on bulk density

CONCLUSION

The findings obtained from this study, which was based on the classical hand-molding method of brick construction, demonstrated that sludge can be constructively and successfully incorporated into bricks with sludge additions ranging from 5 to 45 wt% (dry basis). By taking into consideration the water absorption, compressive strength, and heavy metal leaching results, it can be concluded that an apparent sludge amendment of up to 40 wt% in clay bricks can be used comfortably in non load bearing partions of the building whereas up to 30% sludge bricks can be used confidently as an alternative for normal bricks in both load bearing and non load bearing areas of the building. The present study gives further scope of research to bring out quite viable bricks by mixing with other material to have maximum utilization of sludge.

REFERENCES

[1] Lin DF, Wen CH. J Environ Eng 2001; 127(10):922–927.
[2] Alleman JE. Beneficial use of sludge in building components. Final report, Grant No. ISP-8021357, National Science Foundation, West Lafayette, Indiana, 1983; 101.
[3] BS 1377. 1990. Methods of test for soils for civil engineering purposes. Part 2: classification tests. British Standards Institution, London, England.
[4] Okuno N, Takahashi S. Water Sci Technol 1997; 36 (11): 243–250.
[5] Alleman JE. Interbrick 1987; 3: 14–16.
[6] Ang Kok Hua. Use of sludge as a Consturction material undergradrate thesis. Dept. of Civil Engineering. National University of Singapore: 1982; 65–70.
[7] Dondi M, Marsigli M, Fabbri B. Tile Brick Int 1997; 13: 218–225.
[8] Tay JH. Bricks manufacture from sludge. J Environ Eng 1987; 113 (2):278–283.
[9] Trauner EJ. J Environ Eng 1991; 119 (3): 506–519.
[10] Wiebusch B, Seyfried CF. Water Sci Technol 1997; 36 (11): 251–258.