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Research Paper

STABILIZATION OF AMMONIA AND ORGANIC MATTER CONTAINING LEACHATE USING CEMENT AND CLAY

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Abstract: This preliminary study investigated stabilization process of ammonia and organic matter containing leachate in a laboratory scale reactors. The process involved mixing reactive materials of cement and clay with untreated leachate to immobilize the contaminants. Ammonia ion was significantly removed from the solution that might be due to the raising of pH and chemical binding with negative charge of clay. Organic matter removal increased as ammonia removal increased, revealing organic matter immobilized by chemical binding instead of pH dependent process.

Keywords: Basic pH, contaminants immobilization, physiochemical process, reactive materials

INTRODUCTION

Leachate was a liquid that has percolated through solid waste and extracted dissolved or suspended materials from the waste. Monthly monitoring of physical and chemicals characteristics for leachate had been carried out in the existing leachate treatment plant of Benowo, Surabaya [1]. The untreated leachate characteristized by high concentration of dissolved solids (TDS), suspended solids (SS), sulphide (S), ammonia (NH4-N), BOD and COD of more than 1800, 350, 1.4, 65, 1900 and 3800 mg L^{-1} respectively. Monthly fluctuation of ammonia showed at high level in dry season, suggesting that ammonia was not volatilized in solid waste mass [2, 3].Thus the untreated leachate chractristics potentially created harmful effects towards living environment where the leachate passed through and disposed off [4]. In addition, the existing leachate treatment plant, consisting mainly sedimentation and filtration processes could not produce ammonia and organic matter containing treated leachate that met the required standard of EJGR45 [5]. Therefore an attempt to reduce the chemicals at the source of leaching was addressed. Alternative technologies for on-site treatment could be used such as denitrification wall, permeable reactive barrier, chemical barrier and solidification and stabilization [6, 7]. However, for site suitability, the current research investigated stabilization process by using cement and clay which were readily available, cheap and easy for operation and handling. The objective was to get the composition of cement and clay that brought about high removal of the contaminants.

MATERIALS AND METHODS

Clay soil sample was collected from the adjacent field of solid waste disposal site. The sample was blended with clean water several times and filtered in order to remove residues. Following oven dried at 105 C for 24 hours, the sample was grinded and filtered in order to collect fines clay particles. In addition, commercial white cement was provided in this treatment. The chemical composition consisted of CaO 63%, SiO_2 22%, Al_2O_3 6%, Fe_2O_3 5%, and MgO 4%. A gel was formed when the cement mixed with water.

Four material compositions were organized for a weight of 100 g each. These were cement 100%, cement 75% + clay 25%, cement 50% + clay 50% and cement 25% + clay 75%. Each mixture was put in a jar and poured with distillate water to the final weight of 1000 g and therefore the weight fraction of the materials was 10 %.

Laboratory scale reactors were provided using jar-test apparatus. Each jar was amended with 100 mL untreated leachate which was collected from the existing collection pond. Each suspension was stirred 100 rpm for 10 minutes followed by 60 rpm for 5 minutes. The stirring arrangement repeated twice. Sedimentation of solid materials was applied for 10 minutes. The liquid phase was collected for chemicals measurement.

Chemicals measurement consisted of ammonia (NH4+), BOD and COD which were carried out in accordance with Standards Methods [8]. These were applied for untreated leachate, cement and clay mixture, and the treated leachate.

RESULTS AND DISCUSSION

The pH of untreated leachate was 7.79±0.32. Mixing the untreated leachate with cement resulted in raising sharply the pH of solution to 11.37±0.59. The level of raising pH was lowered in the presence of clay. The untreated leachate contained 65.88±5.93 mg NH4-N L^{-1}, 1134.53±102.13 mg BOD L^{-1} and 1772.18±159.52 mg COD L^{-1}. Cement and clay treatments resulted in an increase of ammonia and organic matter removal. Figure 1 presented the increasing of pH of solution in addition to the removal of ammonia and organic matter.

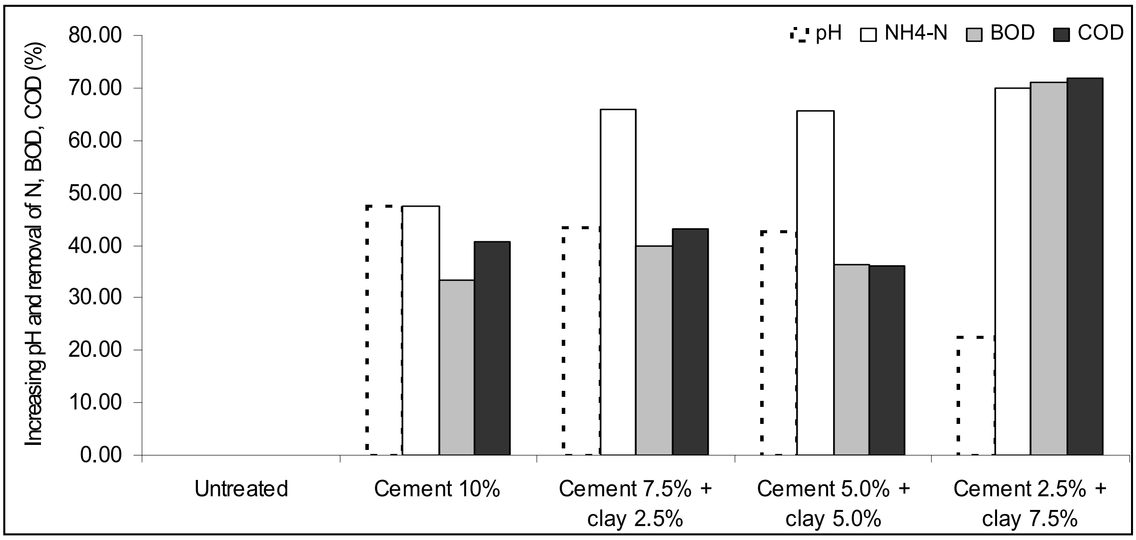

Fig. 1: Performance of ammonia and organic matter removal at basic pH

It demonstrated that ammonia reduced at basic pH. Moreover, reduction of soluble ammonia was possibly enhanced by ionic attraction between ammonia ion and negative charge of clay. This represented in an increase of ammonia reduction as clay content increased.

The results of organic matter removal were in contrast with Elie *et al* [9]. They found increasing amounts of dissolved organic compound in solution following treatment of oxidized samples by using deionized water and cement solution. The dissolved organic compound amounts were higher at basic pH than at pH close to neutrality. Therefore the current research revealed that the removal of organic matter containing leachate was not pH dependent. Figure 1 showed the removal of organic matter increased as the removal of ammonia increased which was possibly because of chemical binding among ammonia, organic matter, cement and clay.

Cement as such and clay amended cement up to equal proportion performed no significant differences in removing organic matter. Cement to clay ratio of 1: 3 offered significantly the highest removal of ammonia and organic matter at the level of 70 %. The latter provided the leachate contained 20 mg NH4-N L^{-1}, 340 mg BOD L^{-1} and 530 mg COD L^{-1} that could be treated sufficiently using the existing treatment system at Benowo conditions.

CONCLUSIONS

The presence of cement and clay resulted in raising pH of leachate at least 9.00. The basic pH conditions brought about ammonia immobilization to the reactive materials in which physiochemical binding might occurred. The latter process might be responsible for removing organic matter from the leachate. It was suggested to apply more clay than cement to achieve high removal performance of ammonia and organic matter containing leachate.

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