

ABSTRACT

Partially stabilized leachate is known to contain contaminants harmful to the environment. The combined physicochemical treatment was generally used to treat these recalcitrant. However, the existing technology is still unsatisfactory to fulfil strict discharge limits and is subjected to various operational issues. This thesis aims to evaluate the effectiveness of combining ammonia stripping and subsequent acidification as a pre-treatment for GAC adsorption and also evaluate the impact of ammonia removal efficiency on the economic cost of the full-scale ammonia stripping system. The partially stabilized leachate was characterized by a high COD (2800 mg/L), UV_{254} (15.92), and ammonia (920 mg/L) concentration. A response surface methodology (central composite design) was used to optimize the variables such as pH (9-12), air to water ratio (5-10L/Air/min/L-Leachate), and temperature (30-60 °C) for the lab-scale diffused ammonia stripper. Then, the effect of lime (from the ammonia stripping process) and acidification for optimization GAC adsorption was evaluated by varying the lime dosage (0 to 20 g/L) and pH (2 to 12), respectively. Next, the equilibrium isotherms and kinetics of the adsorption process were investigated. Finally, the economic feasibility of the proposed treatment was conducted using Aspenplus®. The optimization process using RSM for the diffused ammonia stripper had predicted the optimum condition for ammonia removal, corresponding to 95.6% ammonia removal. The acidification after lime treatment has significantly improved the adsorption of organics (COD) by more than 90%, showing a significant improvement in the adsorption performance by using the granular activated carbon. The equilibrium and kinetic adsorption follow the Redlich-Peterson isotherms (R^2 : 0.99902) and pseudo-second-order degree kinetics (R^2 : 0.993-0.998). The economic optimums for the ammonia stripping and adsorption process scale-up simulation were found to be at RM338.66/kg (79.60 US\$/kg) of ammonia removed

at ammonia concentration of 244 ppm with 95% removal efficiency at an operating temperature of 60 °C. In conclusion, these results demonstrate that the combined process is an effective treatment for the treatment of partially stabilized leachate in complying with strict discharge limits.

Keywords: Landfill leachate, ammonia, COD, pre-treatment, GAC

Rawatan Air Larut Resapan Pelupusan Sampah Separa Stabil menggunakan Gabungan Pelucutan Amonia dan Adsorpsi GAC

ABSTRAK

Air larut resapan pelupusan sampah yang separa stabil mengandungi bahan cemar yang berbahaya bagi alam sekitar. Rawatan fizikokimia gabungan biasanya digunakan untuk merawat bahan cemar organik ini. Walau bagaimanapun, teknologi yang ada ini masih tidak memuaskan untuk memenuhi had pelepasan yang ketat dan mengalami pelbagai masalah operasi. Tujuan tesis ini adalah untuk menilai keberkesanan menggabungkan pelucutan amonia dan pengasidan dan seterusnya sebagai pra-rawatan untuk penjerapan GAC untuk penyingkiran amonia dan COD dan juga impak penyingkiran ammonia terhadap kos ekonomi sistem ammonia stripping yang berskala penuh. Air larut resapan pelupusan sampah yang separa stabil dicirikan oleh kepekatan COD yang tinggi (2800 mg/L), UV_{254} (15.92) dan ammonia (920 mg/L). Response surface methodology (central composite design) digunakan untuk mengoptimumkan pembolehubah seperti pH (9-12), nisbah udara kepada air (5-10 L/Air/min/L-Leachate), and temperature (30-60 °C) bagi diffused ammonia stripper. Kemudian, lime treatment (daripada proses pelucutan amonia) dan pengasidan sebelum penjerapan GAC untuk penyingkiran COD dinilai dengan mengubah sukatan lime (0-20 g/L) and pH (2-12). Seterusnya, isoterm dan kinetik proses penjerapan disiasat. Akhirnya, usaha mengenalpasti kos ammonia stripping yang optimum pada skala penuh dilakukan menggunakan Aspenplus®. Proses pengoptimuman menggunakan RSM untuk proses pelucutan amonia telah meramalkan keadaan optimum untuk penyingkiran ammonia, bersamaan dengan penyingkiran ammonia 95.6%. Pengasidan selepas rawatan lime telah meningkatkan dengan ketara penjerapan organik (COD) sebanyak lebih daripada 90%, menunjukkan peningkatan ketara dalam prestasi penjerapan dengan menggunakan

granular activated carbon. Model keseimbangan dan kinetic proses penyerapan mengikuti kinetik darjah pseudo-second-order (R^2 : 0.993-0.998) dan model Redlich-Peterson (R^2 : 0.999). Kos ekonomi yang optimum untuk simulasi peningkatan proses pelucutan dan penyerapan amonia didapati pada RM338.66/kg (79.60 US\$/kg) ammonia yang disingkirkan pada kepekatan amonia 244 ppm dengan kecekapan penyingkiran 95% pada suhu operasi 60 °C. Kesimpulannya, keputusan ini menunjukkan bahawa proses gabungan adalah rawatan yang berkesan untuk rawatan larut larut separa yang stabil dalam mematuhi had pelepasan yang ketat.

Kata kunci: *Larutan lesap tapak pelupusan sampah, amonia, COD, pra-rawaran, GAC*