ABSTRACT

Sustainable and energy efficient disposal of solid waste has been challenging since long decades due to unprecedented increase in urbanization and industrialization. Municipal solid waste (MSW) and industrial organic wastes are the wastes of concern these days. Open dumping is a very common practice of disposing these wastes, which imparts immense environmental challenges and health hazards. Besides being the foremost method of treating MSW, conventional dry tomb landfill pertains series of shortcomings involving slow degradation rate, lower landfill gas generation and leachate toxicity. However, bioreactor landfill facilitates early bio-stabilization in comparatively shorter period with augmented landfill gas yield and significantly decreased leachate strength. Co-disposal MSW and organic sludges from industries in bioreactor landfills could reinforce enhanced bio-stabilization rate, biogas generation and dilution of toxicants in waste mass. Therefore, in this research, the co-landfilling of MSW and distinct industrial organic wastes from paper, sugar and distillery industries have been performed in simulated landfill bioreactors. Effluent treatment and de-inking sludges from paper mill have been proved to be excellent substrates for enhancing biodegradation, biomethane generation and reducing heavy metal bioavailability. In particular, the bioreactor with effluent sludge co-disposed with MSW in equal proportion fetched more than 98% organic pollutant removal from leachate with eight times more biomethane production as compared to control MSW landfill. Further, in order to overcome the shortcomings of sole landfilling, dual-mode approach with consecutive dry tomb – bioreactor landfilling (DTL – BRL) was investigated for co-disposal of MSW and pressmud from sugar mill. Pressmud co-disposal with MSW in such dual mode landfilling approach not only enhanced stabilization rate but also assisted in reducing heavy metal toxicity of solid digestate. Another semi-solid viscous waste from distillery industry, molasses was also co-landfilled with MSW in

distinct proportionate dilutions. Presence of degradable sugar content in molasses considerably augmented the landfill gas generation in anaerobic MSW landfill reactor. Nevertheless, its excess disposal quantity imparted extra heavy metals and organic loading to degrade.

Hybrid operation with series of intermittent aerations in anaerobic bioreactor co-landfill simulators significantly enhanced leachate decontamination rate and improved biodegradation kinetics. Aeration assisted in balancing the pH conditions of landfill bioreactors which ultimately favored the methanogenesis process. Furthermore, lime sludge from paper mill was utilized for maintaining favorable MSW landfilling conditions in three distinct quantities. The leachate results demonstrated a maximum of 76.47% organic loading reduction with 3.31 times more biogas yield than that of control MSW landfill through optimum dose of 6.25% LS addition. The influence of disposing pretreated industrial organic waste in MSW landfill was also assessed through investigation of pressmud compost co-disposal with MSW in anaerobic bioreactor landfills. Hydrolyzed pressmud through composting improved the overall digestion rate by providing extra growth sites for degrading microorganisms and enhanced cumulative landfill gas yield. Lastly, the neural network and regression models worked efficiently for predicting leachate pollutant removal and landfill gas generation during anaerobic co-landfilling operation. The research carried out expands the dimensions of co-landfilling of various other non-hazardous industrial sludges with MSW for enhancing bio-stabilization rate and resourceful recovery from disposed biomass.

The research work explored one of its kind findings to support simultaneous treatment and resourceful utilization of challenging solid wastes generated from industries and municipalities for bioenergy generation. The heavy metal bioavailability as first such extensive study in any landfilling scenario, expands the horizon of prospective works to be conducted in the area of co-landfilling.