QUARTERLY PROGRESS
REPORT
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PROJECT TITLE: CO_2 capture from landfill gas using amine based silica sorbents

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Research Description:
Biogas is a renewable energy source of methane that can be used directly as fuel for combustion engines, gas turbines, and fuel cells as an energy source after its purification. CO_2 being the major contaminant (30–50%), its removal from methane becomes one of the critical steps in upgrading to increase the energy content of the biogas. The goal of the project is to identify a low cost adsorbent for CO2 separation from biogas and mesoporous silica functionalized with amine groups have been proven to be good adsorbents of CO_2 with high selectivity, low energy utilization and low regeneration costs. This study will benefit WTE processes through improved economics.

Work accomplished during this reporting period:
For the period outlined in this first report, background research has been done to find an appropriate adsorbent for the CH_4/CO_2 separation by functionalizing mesoporous silica. In the work reported here, SBA-15 is used as the support and APTES (primary [3-aminopropyl-triethoxysilane) is used to functionalize the mesoporous silica.

SBA-15 was prepared by dissolving 6.0 g of co-polymer P123 $(EO)_{20}(PO)_{70}(EO)_{20}$ (Aldrich) in 180ml DI water (in an acidic medium). The solution was continuously stirred for 3 h at 40^0 C after which tetraethyl orthosilicate (TEOS) (which is the silica source) was added to the mixture. The mixture was stirred for 24 h after which it was aged for 8 h without stirring at 110^0 C. Finally, the solid recovered by washing and centrifuging was calcined at 500 K for 6 h. APTES loading on silica was achieved using conventional grafting techniques. For functionalization of the silica, a calculated amount of amine was added to the SBA-15 (using toluene as solvent). It was stirred for 16 hours in a reflux after which it was washed and dried at 120^0 C.

N_2 physisorption was used for the characterization of SBA-15 and APTES functionalized SBA-15. Pore characterization was studied using BET to understand the structure of the adsorbent. The BET surface areas are presented in Table 1.

Table 1: Characterization data of the SBA-15 and amine-functionalized SBA-15

Sample	SSA (m2/g)	PV (cc/g)	PD (nm)
SBA-15	672	0.81	7.8
APTES - SBA 15	354	0.516	6.1

From Table 1, we can see that the pore volume and the surface area of the silica decreased once the APTES is added, confirming that amine functionalization process has occurred inside the pores of the SBA-15. Further the amount of loading onto the silica was studied. The actual loading of the amine was determined by weighing 1 g of sample before and after calcination at 800 C. It was seen that for a 21 weight percent of APTES added the actual loading was around 12 weight percent in the final adsorbent sample.

The main challenge faced at this stage was to improve the loading of the amine group onto the support. The approach to solve this challenge will include varying the stir time and changing the drying temperatures of the adsorbent. Increasing the amine loading will help in improved adsorption of CO_2.

Future Tasks:

The future work would be to load different weight percent of amine groups onto the support and characterize them to find the amount of CO_2 adsorbed by the various samples. It will be done by conducting CO_2 adsorption experiments at room temperature and by obtaining CO_2 isotherms. This will help to determine the best adsorbent to use for the remaining portion of the study. Cyclic adsorption/desorption studies will be conducted over extended time periods to determine the long term stability and performance of the adsorbents.