QUARTERLY PROGRESS REPORT
March 2020 – May 2020

PROJECT TITLE: ASSESSMENT OF LOW-COST ADSORBENTS FOR SILOXANES REMOVAL FROM LANDFILL GAS

PRINCIPAL INVESTIGATOR(S):

John N. Kuhn
Department of Chemical & Biomedical Engineering
University of South Florida
Email: jnkuhn@usf.edu
Phone: (813) 974 – 6498

Babu Joseph
Department of Chemical & Biomedical Engineering
University of South Florida
Email: bjoseph@usf.edu
Phone: (813) 974 - 0692

Student Researchers: Rarosue Amaraibi (PhD) and Seth Williams (BS)

PROJECT WEBSITE: **http://www.eng.usf.edu/~jnkuhn/Hinkley2019.html**

Research Description:

Landfill gas (LFG) is increasingly used and researched as a feedstock for a variety of traditional and proposed Waste-to-Energy (WTE) technologies, which includes electricity generation, compressed natural gas, or liquid hydrocarbon fuels. In these various scenarios, contaminants in the LFG can have substantial economic and environmental consequences in the WTE processes.

Siloxanes are increasing contaminants of LFG as a lot of consumer products being land-filled contain this compound. Siloxanes in biogas cause damage to machines if not removed because it thermally decomposes to silica. This leads to high maintenance cost of WTE technologies thereby serving as a disadvantage to the economics of the entire process. Current purification techniques available for siloxanes removal are too expensive; it costs less to repair damaged engine parts than to adopt current siloxane purification techniques. In order to accelerate adoption of WTE processes, a need for more economical methods for removing siloxanes from LFG exists. The goal of this research project is to develop low cost strategies for siloxane removal from LFG. The study will be evaluating the economic potential and environmental impact of selected scrubbing technologies using low cost adsorbents.

Work accomplished during this reporting period:

For the period outlined in this report, water vapor and carbon dioxide adsorption isotherms were generated for clinoptilolite and diatomaceous earth (DE) samples in order to examine the competition of adsorption sites by these compounds. A static adsorption instrument (Autosorb; Quantachrome) was used in conducting the vapor sorption experiments. N_2 physisorption analysis was also conducted on DE samples to determine its surface area. The N_2, CO_2, and water vapor adsorption isotherms generated for clinoptilolite and DE samples are displayed in figure 1 and figure 2 below.

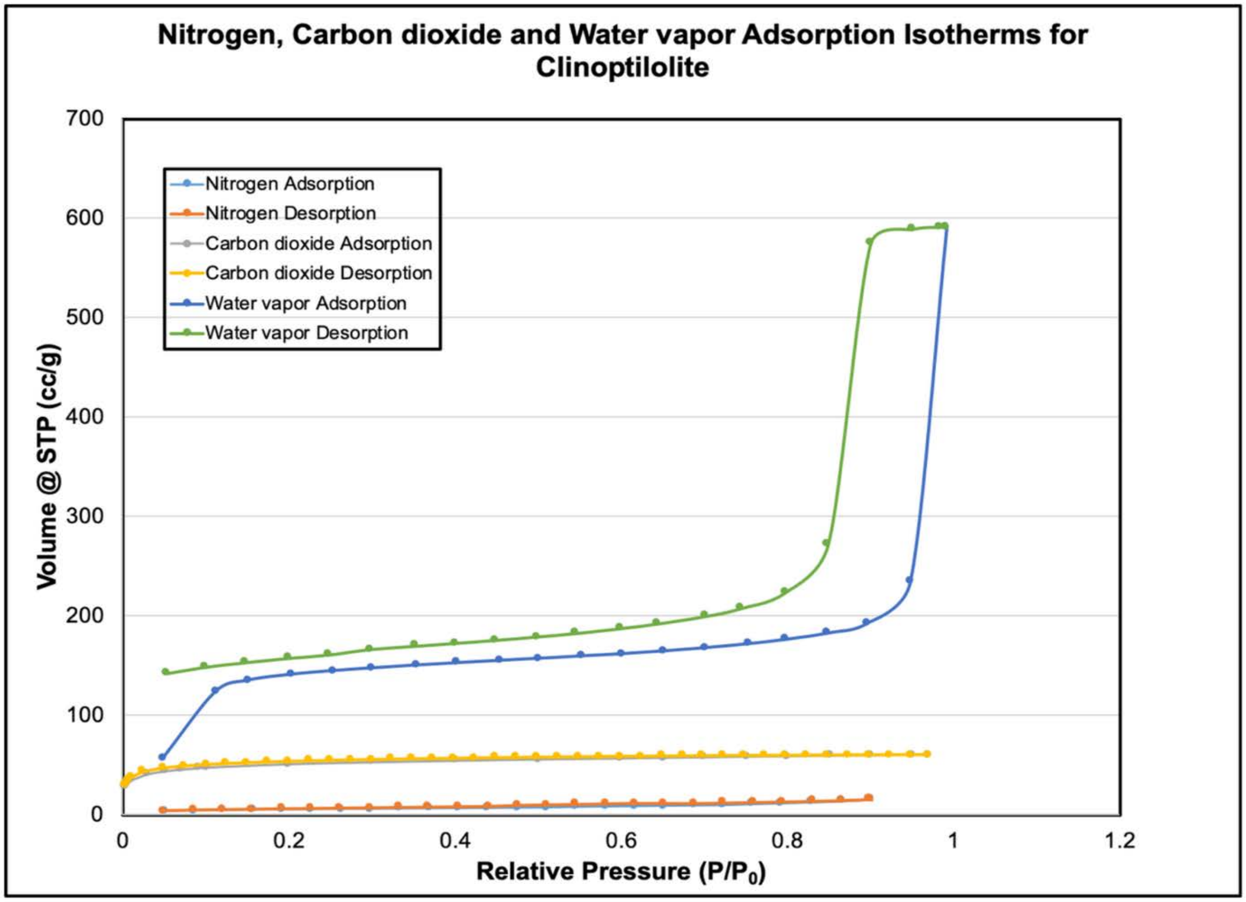

Figure 1: Nitrogen, Carbon dioxide and Water vapor Adsorption Isotherms for Clinoptilolite

From the adsorption isotherms derived for clinoptilolite as displayed in figure 1, clinoptilolite was observed to possess a water vapor adsorption capacity of 102.9 mg H_2O/g clinoptilolite at room temperature and a CO_2 adsorption capacity of 96.3 mg CO_2/g clinoptilolite at room temperature. The N_2 adsorption isotherm was used to determine the BET surface area of clinoptilolite which resulted in 17 m^2/g as reported in the first quarterly report.

The adsorption isotherms generated for DE as displayed in figure 2 shows that DE possesses a water vapor adsorption capacity of 0.0414 mg H_2O/g DE at room temperature and a CO_2 adsorption capacity of 0.0434 mg CO_2/g DE at room temperature. The N_2 adsorption isotherm was used to determine the BET surface area of DE which resulted in 1.037 m^2/g. The N_2 physisorption analysis results for DE are displayed in table 1 below.

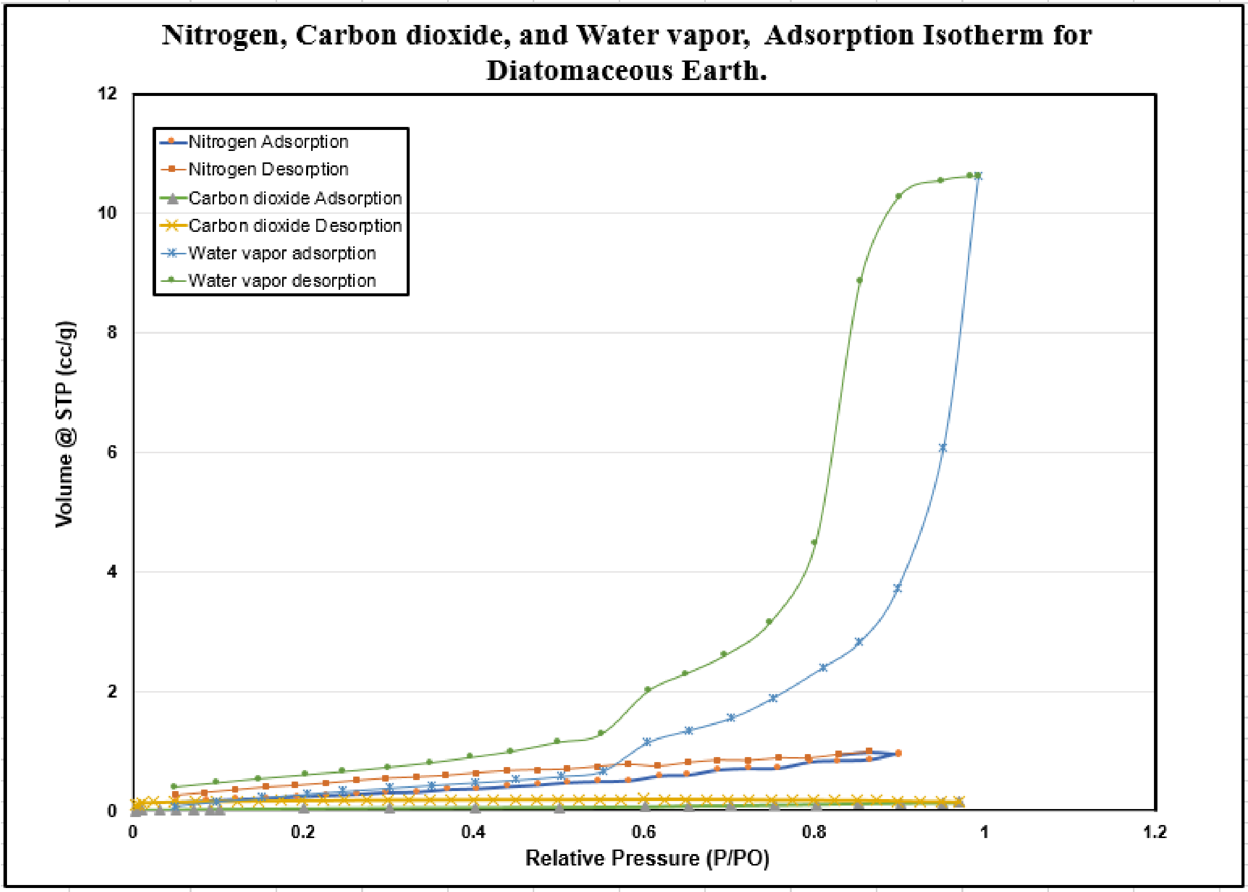

Figure 2: Nitrogen, Carbon dioxide and Water vapor Adsorption Isotherms for Clinoptilolite

Table 1: N_2 physisorption analysis of DE.

Diatomaceous Earth Sample	Specific Surface Area [m^2/g]		Pore Volume [cm^3/g]	Average Pore Diameter [nm]
	S_{BET}	S_{BJH}	V_{BJH}	D_{BJH}
Powder	1.037	0.839	0.001	5.225

Future Tasks:

The future work would be to:

- Characterize biochar and crushed glass.
- Generate hexamethyldisiloxane (L2) and octamethylcyclotetrasiloxane (D4) adsorption isotherms for selected adsorbents.
- Conduct breakthrough experiments on the selected adsorbents using siloxanes in inert gas, surrogate biogas and real landfill gas (LFG).
- Determine adsorption capacity and regeneration ability of adsorbents for selected siloxanes in inert and surrogate LFG.
- Test low cost/waste inorganic materials for thermal degradation performance of selected siloxanes in inert and surrogate LFG.