Polyethyleneimine Impregnated Adsorbents for a Community-Based Carbon Capture and Sequestration Approach

Lahiri, Nishant (School: Corning-Painted Post High School)

Traditional Carbon Capture and Storage uses a combination of technologies to capture, transport, and store carbon dioxide (CO_2) from large point sources such as coal or natural gas-fired power plants. The Integrative Carbon Reduction Technology (iCART) system envisions indoor, residential approaches similar to recycling to engage the community in mitigating anthropogenic emissions. For its direct-air capture (DAC) unit, substrates with adsorbed polyethyleneimine (PEI) were evaluated in terms of capture and cyclic capacity, ambient capture efficiency, material degradation, and applicability in integrated indoor CO_2 capture units. The textile substrates nylon, ceramic wool, dust sheets, HVAC air filters, and cotton were compared to polyester polyethylene silica aerogel composite fabric (CSAF) as a gold standard. The Brunauer-Emmett-Teller (BET) method was used for surface area measurements, while mass measurements and nondispersive infrared (NDIR) CO_2 sensors were used to assess capture capabilities in pure and ambient CO_2 environments. Cotton had a low surface area (SA) of 1.28 m2/g, whereas the SA of CSAF was 236.00m2/g. The CSAF material adsorbed 166 g-PEI/m2 while cotton adsorbed only 3.64 g-PEI/m2. However, cotton allowed for much more effective use of PEI: 3.022g CO_2/g-PEI, compared to 0.205g-CO_2/g-PEI for CSAF. This conservation of the active capture agent in conjunction with inexpensive and robust textile substrates would improve capture/cost ratios. All tested substrates showed 100% recyclability. Recycled weekly, an iCART household unit would have the capture potential of 2.145 MT/year, equivalent to planting ~100 trees.

Awards Won:

First Award of $5,000