TEAM C-HELIX

EXHIBITIONS

ARTIFICIAL SEQUESTRATOR

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ABSTRACT:

Carbon capture is one of the foremost methods for curtailing greenhouse gas emissions. Incumbent technologies are inherently inefficient due to thermal energy losses, large footprint, or degradation of sorbent material. We report a solid-state faradaic electro-swing reactive adsorption system comprising an electrochemical cell that exploits the reductive addition of CO2 to quinones for carbon capture. The reported device is compact and flexible, obviates the need for ancillary equipment, and eliminates the parasitic energy losses by using electrochemically activated redox carriers. An electrochemical cell with a polyanthraquinone–carbon nanotube composite negative electrode captures CO2 upon charging via the carboxylation of reduced quinones, and releases CO2 upon discharge.

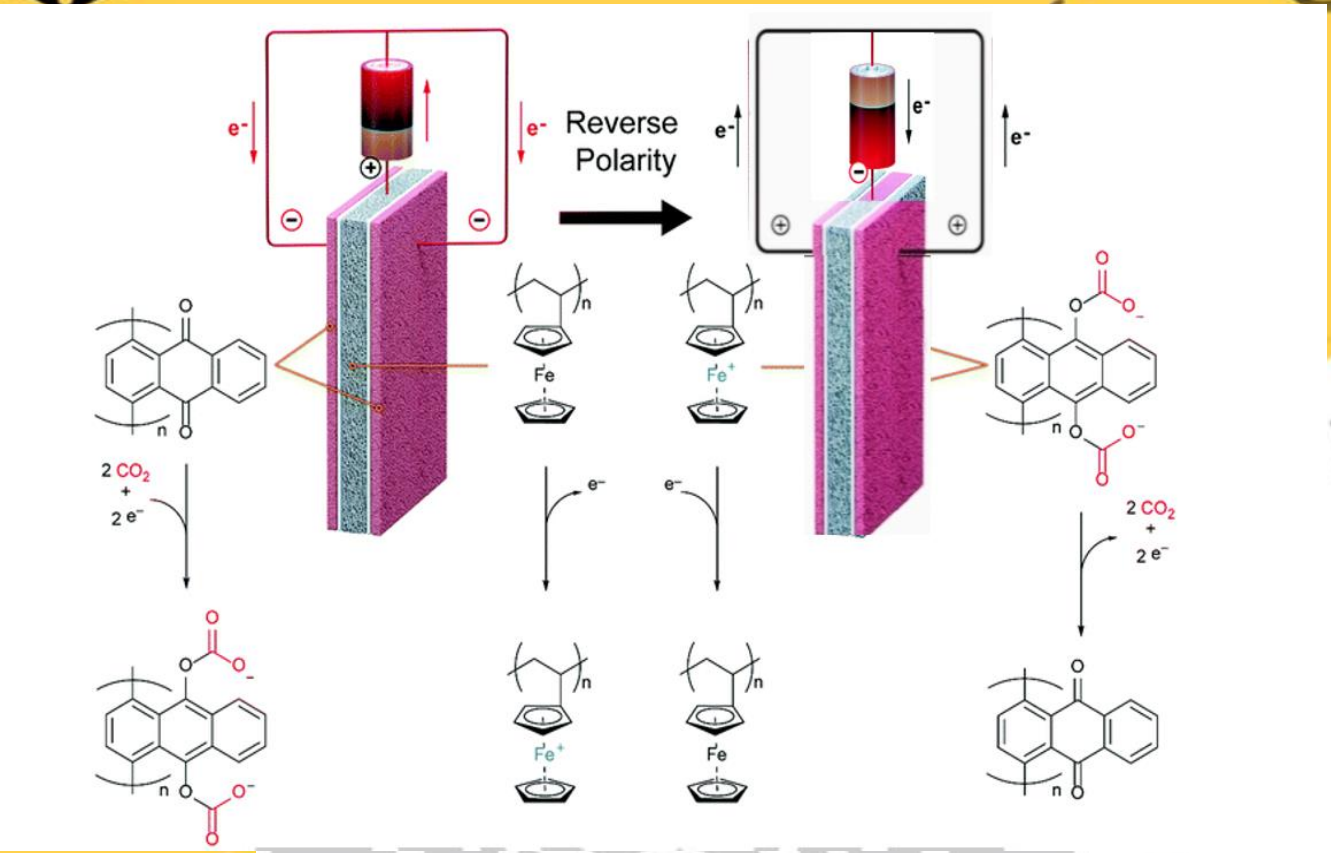
OBJECTIVES:

1. Developing technology to reduce rate of concentration of greenhouse gases in air.
2. Reducing pollution in air as well as Globle warming by decreasing concentration of co_2 in atmosphere and in this process, we get pure co_2 can we use directly for general uses.
3. Many of the CO_2-capture chemical processes that involve a capture agent such as amines or solid sorbents require temperature and/or pressure swings to release the captured CO_2 and regenerate the agents for further capture.

   These swings result in inefficiencies due to energy wasted in heating solvents and sorbents, pressurizing feed gas,or drawing a vacuum for desorption but Electrochemical systems can minimize such parasitic energy losses.

EXECUTION:

In this work, we develop a compact electrochemical device for CO_2 capture that eliminates the requirement for complex flow systems, and that can be effective in the treatment of both high and low concentration feed streams. A quinone-utilizing faradaic electrochemical cell that fulfils these requirements and operates as an Electro-Swing Adsorption (ESA) process. The cell is comprised of two cathode electrode substrates coated with a CO_2-binding quinone–carbon nanotube (Q–CNT) composite sandwiching an anode electrode substrate coated with a ferrocene–CNT (Fc–CNT) composite, with separator membranes between the electrodes. This cell architecture is employed to maximize the CO_2-binding surface area of the cell exposed to gas flow in a parallel passage adsorbent contactor design where stacks of these cells form parallel gas channels. The Fc–CNT electrode serves as an electron source and sink for the reduction and oxidation, respectively, of the Q–CNT electrodes to regulate the uptake and release of the CO_2. Wetting of porous non-woven carbon fiber mats used as the electrode substrates by a room temperature ionic liquid (RTIL) electrolyte enables effective ionic currents to pass through the electrolyte on activation and deactivation of the electrodes and permits the diffusion of CO_2 into the electrolyte-wetted cathodes during capture.



CO_2 SEQUESTRATION: -

Carbon Sequestration is the placement of CO2 into a depository in such way that it remains safely and not released back to the atmosphere but here after the co_2 sequestration we can use it also.

LEARNING OUTCOMES:

- Teaches how to build technology that can save the environment from pollution.
- Teaches how to counteract pollution by taking advantage of it.

SOCIAL BENEFITS:

- Removes harmful gases from the atmosphere.
- If the purge gas were also CO2, the result would be a steady stream of pure CO2 that soft-drink makers could use for carbonating drinks and farmers could use for feeding plants in greenhouses. We get pure co_2 in this tech.
- Electrochemical systems can minimize such parasitic energy losses than other chemical process of carbon capture use capture agent.
- The formed set-up having great durability of electrochemical cells showing <30% loss of capacity after 7000 cylces.

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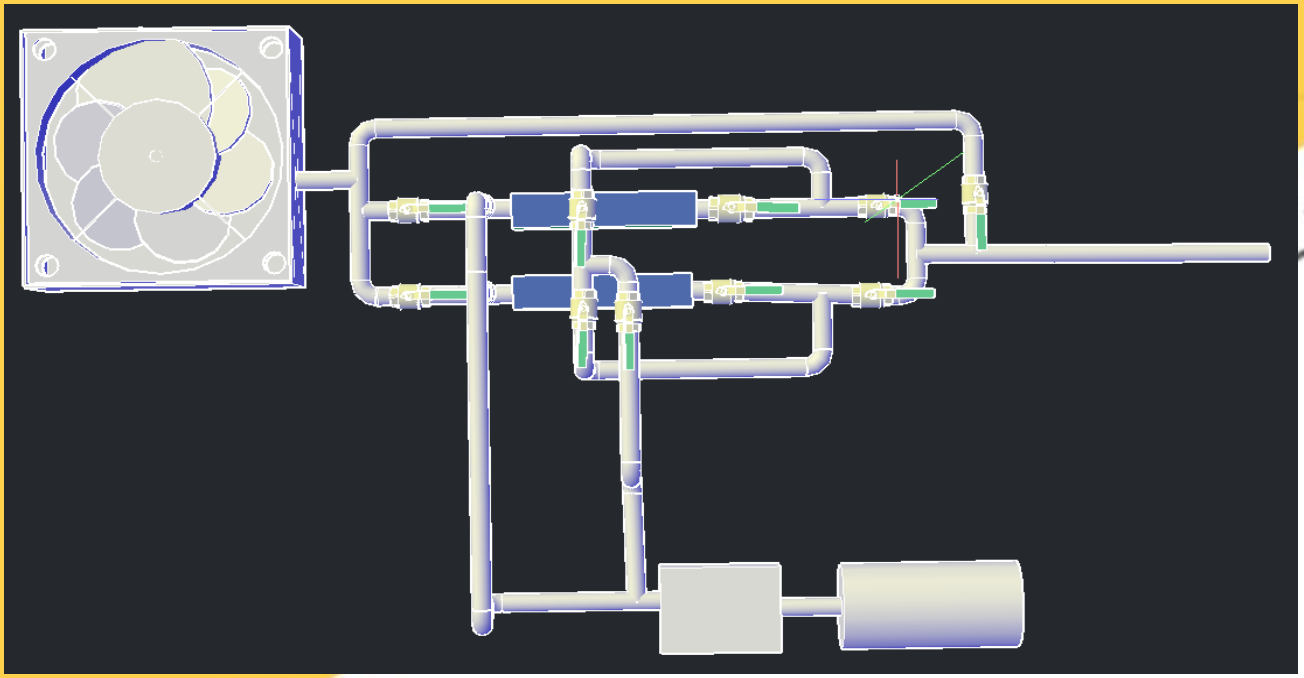
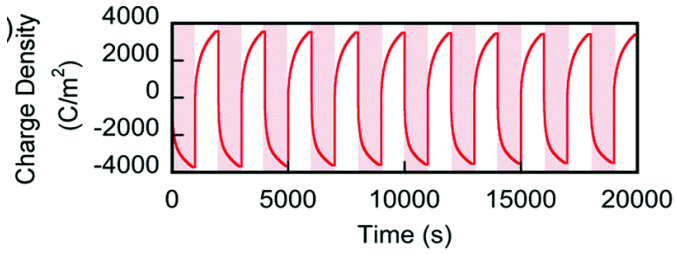
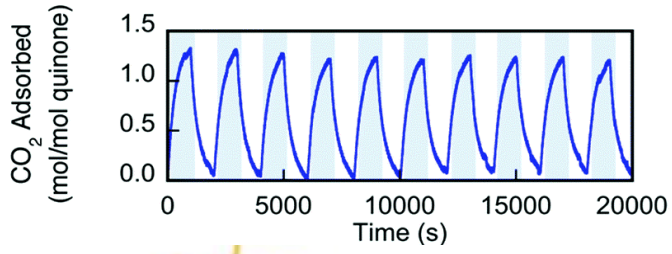
Constructed model:-



GRAPH:





BUDGETARY REQUIREMENTS:

Material required	Specifications	Quantity	Rate (Cost/quantity)
Quinone–carbon nanotube	Coated carbon mat	2	100
Ferrocene–carbon nanotube	Coated carbon mat	1	100
cellulose filter paper	Electrolytic separator	3	5
current collector	Stainless steel		20
Ionic liquid	[Bmim][Tf_2N].	20 ml	20
Pressure transducer		1	1181
Acrylic sheet	12*12 $inch^2$	7	1500
Pipes	7.94 diameter	4 meters	150
knobs		12	300
Acrylic glue		1	300

Total Cost: - 3676 rupee

SOFTWARES REQUIREMENT:

S.NO.	SOFTWARE	SPECIFICATION	QUANTITY	COST /MONTH
1.	Blender	free	1	0
2.	AutoCAD	Free	1	0

Artificial Sequestrator theoretical and Experimental Calculation

Total area exposed of chemical cell = 4 cm^2

PAQ Layer

PAQ-CNT deposition on fiber mat = 1.2 mg/cm^2

so total deposition = 1.2 x 4 = 4.8 mg/ cm^2

PAQ: CNT = 1:3

Total PAQ weight = 1.2 mg/ cm^2

mol of PAQ = 1.2 mg/ cm^2 ÷ 208.21gm/mol= 5.7634µmol

= 5.8 µmol

PVF Layer

PVF-CNT deposition on fire mat =1.4 mg/ cm^2

so total deposition = 1.4 X 4 = 5.6 mg/ cm^2

PVF: CNT = 1:1

total PVF weight = 1.4 X 2 = 2.8 mg/ cm^2

mol of PVF = 2.8 mg/ cm^2 ÷212.07gm/mol

= 13.20 µmol

Theoretical Calculation

If we do not consider the change lost in double layer than

mol of charge = 800mc/96485 = 8.294 µmol

Provided charge = 800 mol

n_f Faradic Efficiency = n F x 100/ Q

= 10^{-6} x 8.29 x 96485 x 100 ÷ 800 x10^{-3}

n_f = 99.98%

If 8.29µmol change activate 8.29 µmol of polyanthraquinone than:

PAQ= 11.6 µmol

Efficiency = 8.29 x 10^{-6} x100 ÷ 11.6 x 10^{-6}

= 71.46 %

Efficiency would be 71.46% of the process but not, this may be due to incomplete charging quinones that are not exposed to electrolyte.

Experimental:

According to experimental data 7.4 mol of charge used to capture -

$n_f = n_f$ x F x 100÷ Q

= 10^{-6} x 7.4 x 96485/ 800 x 10^{-3}

n_f = 89.24%

Now, the total efficiency of the cell to capture co_2

Efficiency = 7.4 X 10^{-6} x 100/ 11.6 X 10^{-6}

= 63.79 %

Amount of co_2 obtained is increases with increasing no. Of cells in the system.