**Post Combustion Carbon Capture Using Polyethylenimine Functionalized Titanate Nanotubes: Review and Preliminary Work**

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**Introduction**

- The increasing CO₂ emissions have a critical impact on climate change and global warming, and have become a matter of great concern.
- Effective CO₂ emission abatement strategies such as carbon capture and storage (CCS) are required to combat this trend.
- Additional energy is required for CO₂ capture, and thus it is critical to capture CO₂ efficiently.
- Three major approaches for CCS are pre-combustion capture, post-combustion capture and oxyfuel process capture.

**Post-Combustion Capture**¹,²

- In post-combustion capture, CO₂ is removed from the flue gas after the combustion of the fossil fuel with air. The flue gas has low CO₂ content and low pressure (about 1 bar).
- Usually the pre-removal of NOx and SO₂ from a flue gas is required before carbon capture.
- Main challenge: the low CO₂ partial pressure in the flue gas. 12-14% CO₂ in a flue gas.
- Big Advantage: Post-combustion carbon capture is especially desirable due to its potential to retrofit existing power plants with reasonable cost.
- CO₂ is captured after the flue gases are cleaned up by Electro Static Precipitator (ESP) and Flue Gas Desulfurization (FGD).

**Absorption (liquid phase)**³,⁴  
- Amine absorption which is commercially available
- Aqua ammonia absorption

**Adsorbents for Post Combustion CO₂ Capture**

Zeolites, activated Carbon, amine functionalized adsorbents and metallic organic frameworks⁴,⁵

**Polyethylenimine (PEI)**

- Linear PEI fragments
- Branched PEI fragments
- Dendrimer

**Possible Mechanisms of CO₂ Reactions with Branched PEI**⁶-⁸

- Reaction between CO₂, H₂O and tertiary amine

**First Application of PEI Polymer on CO₂ Capture**¹⁰

- Able to remove low concentration of CO₂ (~1 Torr) under ambient temperatures and pressure.
- Release CO₂ at low temperature (40°C) in vacuum.

**PEI-Modified Mesoporous MCM-41**¹¹

- PTNTs are semi-assembly nanostructures and have uniform pore size for absorbents and catalysts supports.
- PEI-PTNTs were prepared by wet impregnation method.
- Experiments of PEI-PTNTs-50 exhibited high adsorptions at 75 and 100°C.
- Strong chemical bonding between PEI and PTNTs may guarantee the stability of nanostructures in CO₂ capture from power plant flue gas.

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**References**

[1-12] Various references cited in the text.

**Summary**

- Discussion of post combustion CO₂ capture
- Comparison of absorption and adsorption for post combustion CO₂ capture
- Different promising technologies associated with branched PEI for CO₂ capture
- We prefer to further develop **PEI Functionalized Protonated Titanate Nanotubes** for post combustion CO₂ capture based on our investigation of current solid adsorbent technologies with PEI.

**Our Research Plan and Experimental Setup**

- Develop optimized protocols for synthesis of TiO₂ nanotubes impregnated with PEI.
- Characterize the impregnated nanotubes and use it for refining the parameters for synthesis such as temperature, concentration and time.
- Develop computational fluid dynamics (CFD) simulations of the carbon capture process in the reactor to optimize the reactor conditions for high carbon capture efficiency.
- Demonstrate the efficiency of impregnated TiO₂ tubes for carbon capture under various environmental conditions such as temperature and concentration.
- Establish a validated CFD model and a standard operating procedure for carbon capture using PEI impregnated TiO₂ nanotubes.

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**Schematic of experimental setup**

- CFD modeling: Porous media

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