Transformational Nano-confined Ionic Liquid (NCIL) Membrane for ≥97% CO_2 Capture from Natural Gas Combined Cycle Flue Gas

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About GTI Energy

GTI Energy is a leading energy research & training organization

Across the entire energy value chain

SOURCE | MAKE | MOVE | STORE | USE

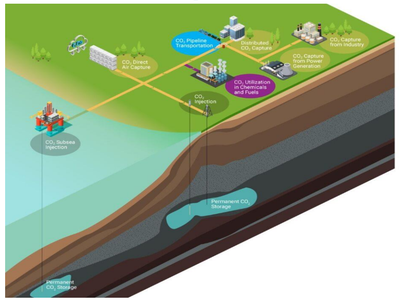
GTI Energy Seeks to Secure, Manage, and Support Large Pilot-Scale and Demonstration-Scale Carbon Capture, Transport, Use, and/or Storage Projects

Why GTI Energy

- Our mission is to be a trusted partner with Industry, Government, and Communities for developing, scaling, and deploying solutions for the transition to low-carbon, low-cost energy systems for public benefit
- We see CCUS as important options to achieve net-zero carbon emissions and advancing these is consistent with our public mission
- We are uniquely qualified to offer services across the entire value chain
- We are actively engaged in and have decades of experience in the development of technologies
- Experienced in managing large integrated projects (examples: H_2 Hubs, STEP, CarbonSAFE, etc.)
- We execute a large portfolio of Government contracts annually with our strong technical, administrative, and organizational structure

GTI CCUS Program

We do capture, conversion, CDR, and transport and storage

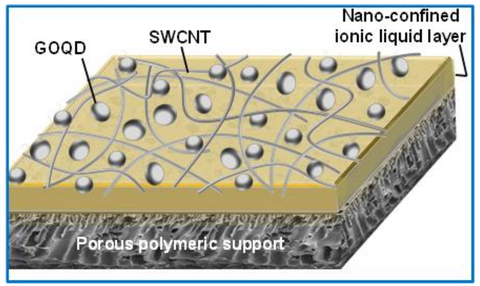


Active DOE Projects

- **Carbon capture**
  - **FE0031946**: 20 TPD facilitated transport membrane (FTM) for power plant application
  - **FE0032466**: 3 TPD ROTA-CAP for steel plant application
  - **FE0032463**: 3 TPD FTM for cement plant application (sub to OSU)
  - **FE0031598**: Bench-scale GO-based membrane
  - **FE0032215**: Nano-confined ionic liquid membrane
  - **FE0031730**: Size-sieving adsorbent (sub to UB)
- **Carbon conversion**
  - **FE0031909:** Membrane reactors for conversion of CO_2 to fuels/chemicals
  - **FE0032246:** Converting CO_2 to carbon-negative alternative cement (sub to WashU)
- **Carbon dioxide removal (CDR)**
  - **FE0031969**: Trapped small amines in capsules (sub to UB)
- **Carbon transport and storage**
  - **FE0032239**: CarbonSAFE Phase II

NCIL membrane

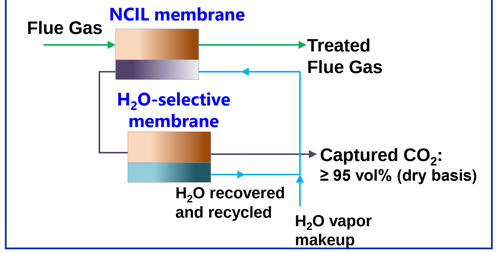
Transformational structure



- Nano-confined space between single-walled carbon nanotube (SWCNTs), combined with nano-sized nitrogen-doped graphene oxide quantum dot (GOQDs) with rich oxygen-containing functional groups, stabilizes the amino acid ionic liquid with amine groups during membrane operations
- The enhanced viscosity of NCIL, resulting from the nano-confined space in SWCNT mesh and favorable interactions between rich functional groups on GOQDs and ILs, significantly inhibits N_2 permeation

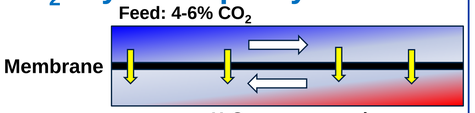
Innovative process design:

NCIL membrane integrated with dehydration membrane to enable ≥97% CO_2 capture



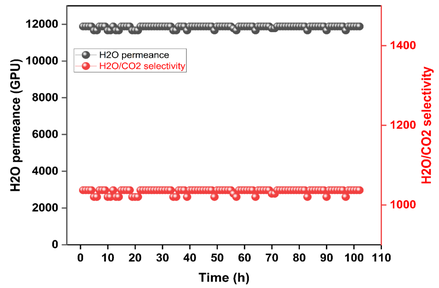
High membrane performance obtained

NCIL membranes showed CO_2 capture as high as 97.6% with CO_2 dry-basis purity of 96.6%

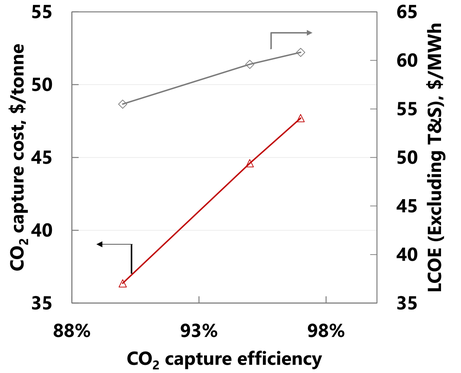


Membrane area, cm^2	75
Temperature, °C	70
Feed pressure, bara	1.0
Permeate pressure, bara	0.10
Feed composition, vol%	5.4% CO_2, 9.6% H_2O, 85.0% N_2
CO_2 capture efficiency	97.6%
CO_2 dry-basis purity, vol%	96.6%

Dehydration membranes showed high H_2O flux and high H_2O/CO_2 selectivity, good stability at 70°C



Initial TEA indicates 23% reduction versus Base Case B31B.97



Technology	CO_2 capture cost at 97% capture, $/tonne
Baseline Case B31B.97	61.8
NCIL membrane process	47.7

Acknowledgements

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