TECHBRIEF

HYDROPHOBIC ALKYL-ESTER PHYSICAL SOLVENTS FOR CO_2 REMOVAL FROM H_2 PRODUCED FROM SYNTHESIS GAS

OPPORTUNITY:

The invention is a family of hydrophobic, low viscosity, low vapor pressure physical solvents with molecular structures consisting of two or more alkyl-ester functional groups on a central hydrocarbon chain. These solvents have been shown to possess high carbon dioxide (CO_2) solubility and absorption selectivity, which make them well suited for the removal of CO_2 from hydrogen (H_2) produced from synthesis gas. This technology is available for licensing and/or further collaborative research from the U.S. Department of Energy's National Energy Technology Laboratory.

CHALLENGE:

Future integrated gasification combined cycle (IGCC) power plants and steam methane reforming (SMR) chemical plants have the potential to reduce the cost of CO_2 capture. These power and chemical plants generate high-pressure CO_2 gas streams from the in-situ water gas shift reaction when producing H_2 used to power the electrical turbines. A variety of methods have been proposed to capture CO_2, including solvent, sorbent, and membrane technologies, with continuous solvent looping systems currently considered to be the most advanced. Precombustion capture of CO_2 is typically accomplished using physical solvents.

State-of-the-art precombustion CO_2 capture processes predominantly employ hydrophilic physical solvents. Current commercial physical solvents touted for IGCC CO_2 capture were developed for removing acid gases from raw natural gas streams. Therefore, they were designed to remove significant amounts of water from the process gas. As such, the focus was on the purification of the process gas with less concern for generation of high-purity CO_2 streams suitable for pipeline transmission and sequestration. While water removal is important for natural gas pipeline applications, it is not favorable for applications in which the fuel stream is directly combusted on-site, as would be encountered in IGCC systems.

OVERVIEW:

Researchers at NETL have developed a family of hydrophobic, low viscosity, low vapor pressure physical solvents with molecular structures consisting of two or more alkyl-ester functional groups on a central hydrocarbon chain. These solvents have been shown to possess high CO_2 solubilities at high CO_2 partial pressures (such as ~ 25 bar) and high CO_2/H_2 absorption selectivity and are well suited for the removal of CO_2 from H_2 produced from synthesis gas. The NETL-developed solvents offer attractive properties for applications involving CO_2 capture from high humidity H_2 gas streams containing elevated partial pressures of CO_2, particularly in IGCC processes. The rare combination of low toxicity, high CO_2 capacity, high selectivity, and low water affinity of these solvents provide opportunities for more efficient, cost-effective and environmentally friendly CO_2 mitigation.

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ADVANTAGES:

- The CO_2 absorption of the solvents listed in the invention compare favorably to currently used solvents such as Selexol, Purisol and Fluor Solvent.
- The solvents listed in the invention exhibit a greatly reduced tendency to absorb water, which imparts advantages in reduced cost and complexity when used in gasification systems.
- This solvent family exhibits excellent CO_2 absorption and good CO_2/H_2 selectivity.
- Solvents listed in the invention are non-toxic and are non-corrosive.
- The solvents are prepared from common chemical reagents easily sourced in large quantities at relatively low cost.
- The tri-esters and tetra-esters reported in this work were all prepared in high yields (>85%).

APPLICATIONS:

Applications of Hydrophobic Alkyl-Ester Physical Solvents include:

- Pre-combustion CO_2 separation and capture at IGCC power facilities
- CO_2 removal during generation of H_2 from reformed natural gas or from syngas
- Adjusting CO_2/H_2 ratio for coal and biomass to liquids
- The removal of CO_2 from syngas for coal and biomass to ammonia/fertilizer
- Natural gas sweetening

PATENT STATUS:

U.S. Patent Pending (non-provisional patent application)

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